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The Nett Warrior System: A Case Study for the Acquisition of Soldier Systems

15 December 2011

by

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THE NETT WARRIOR SYSTEM: A CASE STUDY FOR THE ACQUISITION OF SOLDIER SYSTEMS

ABSTRACT

This project provides an analysis of the Army's acquisition of the Nett Warrior (NW) soldier system. Its objectives are to document the legacy of the system and provide an overview of how acquisition strategy has adapted with respect to key acquisition elements since its inception on September 8, 1993. The product is a document that provides an analysis of the actions taken and the obstacles encountered and how the warfighters, user representatives, materiel developers, and lawmakers dealt with them. The NW need was approved in February 2009. The requirement was to provide improvements for dismounted soldiers in the five specific capability categories of lethality, command and control, mobility, survivability, and sustainment. For a period lasting approximately 20 years, the NW has evolved. Despite the Army's decision to terminate the Land Warrior, the predecessor to the Nett Warrior system, in FY 2007, the NW's foundation for follow-on soldier system initiatives had been established. The success of NW will depend on the program's ability to incorporate soldier-driven design requirements, commercial technology, and thorough system testing.

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LIST OF ABBREVIATIONS AND ACRONYMS

1/17 IN	1st Battalion, 17th Infantry
1/25 SBCT	1st Stryker Brigade Combat Team, 25th Infantry Division
1Q	First Quarter
2–1 IN	2nd Battalion, 1st Infantry Regiment
2SCR	2nd Stryker Cavalry Regiment
2Q	Second Quarter
3Q	Third Quarter
4–9 IN	4th Battalion, 9th Infantry Regiment
4Q	Fourth Quarter
5/2 SBCT	5th Stryker Brigade Combat Team, 2nd Infantry Division
8–1 CAV	8th Squadron, 1st Cavalry Regiment
AAE	Army Acquisition Executive
ACAT	Acquisition Category
ACTD	Advanced Concept Technology Demonstration
ACU	Army Combat Uniform
ADM	Acquisition Decision Memorandum
AETF	Army Evaluation Task Force
AoA	Analysis of Alternatives
ARI	Army Research Institute
ASA(AL&T)	Assistant Secretary of the Army for Acquisition, Logistics, and Technology
ASARC	Army System Acquisition Review Council
ASB	Army Science Board
ATD	Advanced Technology Demonstration/Development
ATEC	Army Test and Evaluation Command
AUSA	Association of the United States Army
BCT	Brigade Combat Team
BFT	Blue Force Tracker
BIT	Built-in Test
BOI	Basis of Issue
BOIP	Basis of Issue Plan
BN	Battalion
C2	Command and Control
C4I	Communications, Computing, Control, Command, & Intelligence
CAS	Close Air Support
CAV	Cavalry
CBRN	Chemical, Biological, Radiological, and Nuclear
CDA	Commander's Digital Assistant
CDD	Capability Development Document
CECOM	Communications Electronic Command
CFP	Contractor Furnished Property
CLS	Contractor Logistics Support

CRNS	Cognitive Radio Network
CO	Company
COA	Course of Action
COP	Common Operational Picture
COTS	Commercial-Off-the-Shelf
CPFF	Cost-Plus-Fixed-Fee
CSA	Chief of Staff of the Army
CSB	Configuration Steering Board
CVC	Combat Vehicle Crewman
DA	Department of the Army
DAB	Defense Acquisition Board
DAGR	Defense Advanced GPS Receiver
DAU	Defense Acquisition University
DBCS	Dismounted Battle Command System
DCS	Deputy Chief of Staff
DoD	Department of Defense
DOT&E	Director, Operational Test & Evaluation
DOTMLPF	Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, and Facilities
EMC	Electromagnetic Compatibility
EMD	Engineering and Manufacturing Development
EMI	Electromagnetic Interference
EPLRS	Enhanced Position Location Reporting System
eSCU	Enhanced Soldier Control Unit
EUD	End User Device
EXFOR	Experimental Force
FBCB2	Force XXI Battle Command Brigade and Below
FCS	Future Combat System
FE	Force Effectiveness
FFW	Future Force Warrior
FM	Field Manual
FOB	Forward Operating Base
FSR	Field Service Representative
FY	Fiscal Year
GAO	Government Accountability Office
GDDS	General Dynamics Defense Systems
GDC4S	General Dynamics C4 Systems
GFP	Government-Furnished Property
GPS	Global Positioning System
GSE	Ground Soldier Ensemble
GSS	Ground Soldier System
GSS Inc I	Ground Soldier System Increment I
GWOT	Global War on Terrorism
HFE	Human Factors Engineering
HMD	Helmet-Mounted Display
HQDA	Headquarters, Department of the Army

HVI	High Value Individual
HVT	High Value Target
IBCT	Infantry Brigade Combat Team
ICD	Initial Capabilities Document
ICT	Integrated Concept Team
ICV	Infantry Carrier Vehicle
IED	Improvised Explosive Device
IFAK	Improved First Aid Kit
IMT	Individual Movement Task
IOTV	Improved Outer Tactical Vest
IN	Infantry
ITA	In-Theater Assessment
JCIDS	Joint Capabilities Integration & Development System
JROC	Joint Requirements Oversight Council
JTRS	Joint Tactical Radio System
KPP	Key Performance Parameters
KSA	Key System Attribute
LOE	Limited Objective Experiment
LRIP	Low Rate Initial Production
LRU	Line-Replaceable Unit
LTI	Lower Tactical Internet
LUT	Limited User Test
LW	Land Warrior
LW–IC	Land Warrior Initial Capability
LW–Manchu	Land Warrior Manchu version after the 4–9 IN (2007)
LW–Strike	Land Warrior Strike version after the 5/2 SBCT (2009)
MBITR	Multiband Inter/Intra-Team Radio
MBL	Maneuver Battle Lab
MCoE	Maneuver Center of Excellence
MDA	Milestone Decision Authority
MOS	Military Occupational Specialty
MRE	Mission-Ready Exercise
MSA	Materiel Solution Analysis
MTBEFF	Mean Time Between Essential Function Failure
MW	Mounted Warrior
NET	New Equipment Training
NPS	Naval Postgraduate School
NSS	Navigational Subsystem
NTC	National Training Center
NW	Nett Warrior
NW Inc I	Nett Warrior Increment I
OBJ	Objective
OCO	Other Contingency Operation
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
ONS	Operational Needs Statement

OPA	Other Procurement Army
OSD	Office of the Secretary of Defense
OT	Operational Testing
OTV	Outer Tactical Vest
P3I	Pre-Planned Product Improvements
P&D	Production & Deployment
PEO	Program Executive Office
PLI	Position Location Information
PLT	Platoon
PM	Program/Product Manager
PM–SWAR	Project Manager Soldier Warrior
RDT&E	Research, Development, Test, & Evaluation
RIP	Relief in Place
RFI	Rapid Fielding Initiative
RR	Rifleman Radio
SA	Situational Awareness
SaaS	Soldier as a System
SAASM	Selective Availability Anti-Spoofing Module
SADL	Situational Awareness Data Link
SASC	Senate Armed Services Committee
SBCT	Stryker Brigade Combat Team
SCR	Stryker Cavalry Regiment
SEP	Soldier Enhancement Program
SFF–B	Small Form Factor B
SIMEX	Simulation Exercise
SIPE	Solider Integrated Protective Ensemble
SL	Squad Leader
SOP	Standard Operating Procedures
SOW	Statement of Work
SRW	Soldier Radio Waveform
STX	Situation Training Exercise
SWAP–C	Size, Weight, Power, and Cost
SWAR	Soldier Warrior
TACOM	Tank-Automotive and Armaments Command
TDS	Technology Development Strategy
TCM	TRADOC Capability Manager
TCM–SBCT	TRADOC Capability Manager–Stryker Brigade Combat Team
TCM–S	TRADOC Capability Manager Soldier
TF	Task Force
TL	Team Leader
TO&E	Table of Organization & Equipment
TPE	Theater Provided Equipment
TRAC	TRADOC Analysis Center
TRAC–WSMR	TRADOC Analysis Center, White Sands Missile Range
TRADOC	U.S. Army Training and Doctrine Command
TRISA	TRADOC Intelligence Support Activity

TST	Time Sensitive Target
TTP	Tactics, Techniques, and Procedures
USACC	United States Army Contracting Command
USAIC	United States Army Infantry Center
USD(AT&L)	Under Secretary of Defense for Acquisition, Technology, & Logistics
USI	Unit System Integrator
VCSA	Vice Chief of Staff of the Army
VIK	Vehicle Integration Kit
WCBF	World Class Blue Force
WSS	Weapon Subsystem

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I. INTRODUCTION

A. BACKGROUND

> Above all, we must realize that no arsenal or no weapon in the arsenals of the world is so formidable as the will and moral courage of free men and women.
>
> – President Ronald Reagan (Department of the Army [DA], 2005b)

In this quote, President Ronald Reagan was referring to the fact that regardless of the technology we develop, the American Soldier will always remain the centerpiece of our military organizations.

> The Army's proud history and traditions point to the countless men and women who have been and are committed to defending the American way of life, citizens who answer the call to duty. Many have made the ultimate sacrifice. Today's soldiers, bound together through the trials of service and combat, hold fast to the professional standards embodied in the Army values and the warrior ethos. In so doing, they will continue to inspire the Nation and the next generation that answers the call to duty. (DA, 2005b, p. 4-52)

In the past two decades, the American military has advanced technologically at an unprecedented rate. More important, it has integrated technology into combined arms and joint operations beyond the militaries of most other nations. From operational and tactical perspectives, military professionals exercise their expertise against intelligent adversaries actively seeking to defeat them in life-and-death situations (DA, 2005b).

Soldiers, rather than equipment, are the centerpiece of the Army's formation and vision for the future. In what way might the military increase situational awareness (SA), enabling soldiers in small units to conduct a higher level of precision maneuver based on intelligence data received prior to and during the conduct of military operations? This increased awareness and understanding would enhance the ability of units to anticipate and respond to enemy contacts. Leaders would be able to exploit SA to better synchronize maneuvers and supporting fires (Project Manager–Soldier Warrior [PM–SWAR], 2010).

One materiel solution, identified as early as 1992, was an integrated, body-worn fighting system that supported the mission of the dismounted combat soldier. The system has had many names during its tenure. It has been called Land Warrior (LW), Ground Soldier System (GSS), and Ground Soldier Ensemble (GSE), but most recently its name was changed to Nett Warrior (NW), after a Medal of Honor winner from World War II (Training and Doctrine Command Analysis Center–White Sands Missile Range [TRAC–WSMR], 2011).

The Ground Soldier System Increment I (GSS Inc I) capability development document (CDD) defines the user's operational requirements for NW. The NW program is using an incremental development approach to accelerate fielding of an integrated dismounted weapon system. The NW system is a sub-element of the Future Force Warrior (FFW),[1] which integrates multiple soldier systems and components while leveraging emerging technologies to provide overmatching operational capabilities to all ground combatant soldiers, small units, and their attachments (PM–SWAR, 2010).

Founded on lessons learned from earlier developments, the NW program harnesses soldiers' field experience, technology maturation, fiscal constraints, and refinement of user requirements. NW is intended to address operational requirements that focus primarily on providing the dismounted soldier with improved SA and command and control (C2), and with hands-free full color displays down to the team leader (PM–SWAR, 2010).

These requirements translate into the user being in the right place, at the right time, with the right equipment, and with near-real-time information. As a result, the new system transforms how Army leaders make decisions and operate so they can be more effective and lethal in executing their combat missions. Improved SA will minimize fratricide and enhance synchronization between maneuver elements, support elements, and other attachments. This capability will be provided by an affordable, tailored system approach that provides required operational capabilities by position within the echelon (PM–SWAR, 2010). The NW provides functional enhancements to the warfighter in line

[1] The FFW is a subsystem of the Future Combat Systems project whose goal is to create a lightweight fully integrated infantry combat system.

with rebalancing the force outlined in the Army Field Manual (FM) 1. Additionally, it supports the Army's vision of facilitating a modular force that can rapidly move wherever needed, applying a more diverse set of capabilities while maintaining the capacity to conduct sustainment operations, allowing it to transition among operations better than its predecessors (DA, 2005b).

Our overarching purpose in this case study was to determine why this system has taken 20 years to evolve and to examine why it is still failing to meet Milestone Decision Authority approval for full-rate production despite deploying multiple times to Iraq and Afghanistan. Through in-theater assessments (ITAs), it has proven itself operationally effective—in most programs, this would be enough to move to full-rate production and deployment to applicable units Army-wide. As we demonstrate in later chapters, soldiers who used this system became so dependent on it that they would not leave the forward operating base (FOB) without it.

The LW system was terminated as a program of record in February 2007 but still deployed for 15 months with 4th Battalion, 9th Infantry Regiment (4–9 IN), 4th Stryker Brigade, 2nd Infantry Division from April 2006 to July 2008. The specific version of the LW system was called the "Manchu" in honor of 4–9 IN. Based on its achievements with 4–9 IN, an operational needs statement (ONS) was submitted by 5th Stryker Brigade Combat Team, 2nd Infantry Division (5/2 SBCT). This urgent operational requirement for warfighting capabilities allowed the LW system to continue service. It was refined, given a faster processor, and renamed the Land Warrior–Strike (LW–Strike). From 2009 to 2010, the system deployed to Afghanistan with 5/2 SBCT (TRAC–WSMR, 2011). The hard work of the LW stakeholders led to the NW's development and refinement. We believe it is their combined efforts that enabled the system to exist today.

B. OBJECTIVES AND APPROACH OF THIS STUDY

In this project we analyze the Army's acquisition strategy for the NW system as it relates to select acquisition strategy elements. The elements addressed in this report are mission need, test and evaluation, technology, and risk management.

This project's objectives are to document the legacy of the system and provide an overview of how the acquisition strategy, with respect to key acquisition elements, has adapted since its inception on September 8, 1993. In this project we analyze the actions taken by the materiel developers, user representatives, lawmakers, and warfighters working together to overcome obstacles in order to deliver revolutionary capabilities to the ground-fighting soldier.

Our analysis focused on the following questions:

- What are the current challenges of the program, and how have they been addressed?
- How has LW's performance in other units (4–9 IN, 5/2 SBCT, 2SCR, and 1/25 SBCT) affected its successor, the NW?
- What is the acquisition strategy behind the NW program?

In order to answer these research objectives, we spoke with several stakeholders in the NW community. We conducted interviews and corresponded with key government officials and contracting personnel, reviewed historical documentation, consulted with colleagues and faculty, reviewed past model and simulation analyses, and conducted after-action reviews. We compiled and reviewed data in order to draw conclusions and report findings that address our research questions. We organized these findings into separate perspectives defined in Section C, Scope.

Interviews and reports that captured the unique insights of key players within the NW program were critical to a complete representation of the issues discussed in this case study. We interviewed or used existing reports from the following stakeholders:

- PM NW;
- PM–SWAR office;
- Training and Doctrine Command Capability Manager Soldier (TCM–S);
- Maneuver Battle Lab (MBL);
- TRAC–WSMR;
- Training and Doctrine Command Requirements Analysis Center–Monterey (TRAC–Monterey); and
- Systems Integration/Robotics Contracting Group, United States Army Tank-Automotive and Armaments Command (TACOM) Life Cycle Management Command.

C. SCOPE

Our goal was to provide a comprehensive case analysis of the acquisition of the NW system and the accomplishments of its predecessor, the LW system. Our analysis begins where a 2008 Naval Postgraduate School (NPS) MBA professional report left off; the earlier report is entitled *The Land Warrior Soldier System: A Case Study for the Acquisition of Soldier Systems*, by Nile L. Clifton and Doug W. Copeland. Their report ends with the LW deployment with 4–9 IN to Iraq in March 2008. Our report begins with analysis of the 4–9 IN in-theater assessment conducted by TCM–S, published October 27, 2008. We chose to analyze the LW system beginning in fiscal year (FY) 2006 in order to incorporate the 4–9 IN legacy. We focused on milestones that the LW system achieved that led to the development of the NW system. It would have been nearly impossible to address all aspects of this highly complex program within the limited scope of this MBA project report. We do not address how Net-centric warfare influenced the program or how the Joint Capabilities Integration & Development System (JCIDS) influenced the key performance parameters (KPP), capability constraints, and schedule. It was not possible to interview all relevant NW/LW participants due to time and resource constraints. In this report we provide an initial evaluation of the NW system leading up to the completion of the Limited User Test (LUT) through the introduction of smart phone technology.

D. ORGANIZATION OF THE REPORT

In Chapter I, we introduce and frame the case study. In Chapter II we provide the historical background of the LW system and detail the incremental approach toward the current status of the NW system. In Chapter III we depict how the program was developed with respect to the user community. In Chapter IV we portray the acquisition strategy and challenges from the materiel developer's perspective and outline some of the development, production, and evaluation challenges. In Chapter V we identify budgeting constraints and other externalities that influenced the acquisition strategy.

In Chapter VI we summarize the next steps, capture lessons learned, and provide recommendations for further research endeavors concerning the development of a soldier-worn command and control system.

II. THE HISTORICAL CONTEXT FOR THE NW SYSTEM

A. INTRODUCTION

> You look at something like the F-22 and the Abrams tanks and you say these are decisive weapons—as soon as the bad guy knows he's going to be flying against an F-22, he doesn't even want to leave the ground. We need to make the U.S. Army Soldier and Marine decisive weapons, and the way you do that is you use Net[t] Warrior. There is no reason in the world why ... a Soldier can't know everything that is moving within a kilometer and he and his leadership can figure out what to do about that thing.
>
> – Mal O'Neill, Assistant Secretary of the Army for Acquisition, Logistics, and Technology (ASA[AL&T]; as cited in Lopez, 2010)

> The Soldier is the Army's most vulnerable asset and is susceptible to almost every threat known on the battlefield.
>
> (TRADOC, 2006, p. 19)

The Army is in a constant state of transformation. It is rich with a history of continuous change while performing its mission. Since the 1980s, the Army has been a national leader in anticipating and leading change. Its deliberate study of technical and professional developments, focused collection and analysis of data from operational and training events, free-ranging experimentation, and transformational processes have made it a model of effective innovation (DA, 2005b). In order to maintain focus on innovation, the Chief of Staff of the Army (CSA) is constantly looking for ways to keep the force deployable within 48 hours in order to fight and win anywhere in the world.

October 1999 was no different in the Army's history. Then-CSA General Eric Shinseki introduced the Army's transformation strategy, which was intended to convert all of the Army's divisions, called Legacy Forces, into new organizations, called the Objective Force—a networked system of systems that included both the LW and Future Combat System (FCS). General Shinseki's decision was said to be in light of the controversial Task Force (TF) Hawk deployment to Kosovo and Albania in 1999 (Feickert, 2006). General Shinseki's intent was to make the Army lighter, more modular, and, more importantly, more deployable (Feickert, 2006).

In August 2003, the newly designated CSA, General Peter Schoomaker, changed the Army's transformation plan and re-designated the Objective Force as the Future Force, emphasizing the importance of fielding useful FCS program capabilities as soon as they became available. Under General Schoomaker's vision, the Army would not wait a decade or more before new technologies and vehicular platforms could be integrated into the force (Feickert, 2006). General Schoomaker's vision was more holistic and jointly applied than his predecessor's. His intent was to deploy relevant technologies, placing more emphasis on Army networks linking forces with each other and with units from other Services.

Before Generals Shinseki and Schoomaker implemented their vision to transform the Army, a group of engineers from the Research, Development, and Engineering Center, U.S. Army Communications Electronic Command (CECOM), were working on the first wearable computer system. This system became known as the Soldier's Computer (see Figures 1 and 2). In 1990, the Soldier's Computer demonstrated its capabilities at the Army Materiel Command's first trade show in Aberdeen, MD. The system weighed 10 pounds and included software that created reports and displayed battlefield situation maps. The system interface included a Global Positioning System (GPS) receiver and the earliest version of a ruggedized helmet-mounted display. A trackball was integrated into the system to allow soldiers to write and send reports to other units. The system was a tradeshow success in the eyes of Army leaders and Congressional members. This success led the Army to invest further research and development in the emerging technology (Zieniewicz, Johnson, Wong, & Flatt, 2002, p. 30).

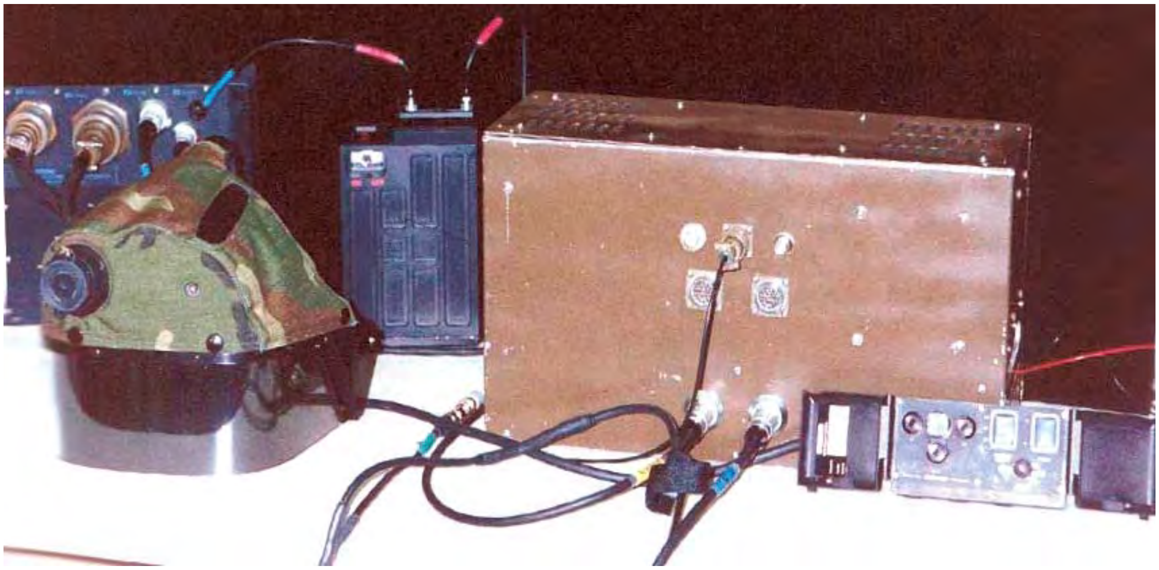

Figure 1. The Soldier's Computer
(Zieniewicz et al., 2002, p. 35)

Figure 2. The Soldier's Computer, 1990
(Zieniewicz et al., 2002, p. 31)

The evolution of wearable computers continued as an open system–bus wearable design was developed called the Soldier Integrated Protective Ensemble (SIPE) Advanced-Technology Demonstration (ATD). The system was developed by the Natick Soldier Center in Massachusetts (see Figure 3). A team led by Carol Fitzgerald began the process of designing the system so that it could capture images, use an integrated radio to transmit data between soldiers, and display data with a helmet-mounted portable display (Zieniewicz et al., 2002).

The initial feedback from the soldiers who used the system was positive. The Natick team continued its work on a more compact and lighter system. Battery consumption was an issue, both in weight and usage. Another issue the team faced was the delay in the capture and playback of images. Due to technology limitations at the time, the system averaged 45–75 seconds to capture and transmit images. During this time-delay, the soldier could not use the system (Zieniewicz et al., 2002).

Figure 3. The Soldier Integrated Protective Ensemble System Used in the Soldier's Computer
(Zieniewicz et al., 2002, p. 33)

As the first step in the evolution of a soldier system, the SIPE exceeded its primary objectives, which were to show the technical feasibility of emerging commercial technologies and to make tradeoffs until an optimal system configuration was developed. The intent of the system was to test a head-to-toe individual fighting system for the ground soldier. When tested in an operational environment, dismounted soldiers equipped with the SIPE demonstrated significant improvements in their ability to shoot, communicate, and survive. The system configuration was a backpack-sized computer

with an 18-pound integrated radio and GPS, an 8-pound helmet-mounted display (HMD), and a 15-pound power pack. The team did not solve the problem of data delay between systems. Despite the limitations in the SIPE's design, the technology was considered state of the art in the early 1990s. The team's research and development was the first to link the individual soldier into a digitized command and control network (Middleton, Sutton, McIntyre, & O'Keefe, 2000).

The success of the SIPE technology focused the Army on its ultimate goal, to produce an integrated fighting system. In 1993, Army leadership began development of the LW system. The LW system had to be able to shoot, move, and communicate on the battlefield, while simultaneously showing the location of friendly and enemy soldiers. In addition, the system had to be easy to use, run seamlessly all day, and be comfortable to wear for continuous operations (Zieniewicz et al., 2002).

The LW system became the first integrated fighting system on the battlefield to successfully transmit information from a dismounted leader to subordinates in a digitized combat environment. The LW has been scrutinized throughout its tenure for not reaching its potential because of technology limitations. To make matters worse, soldiers disliked the system because of its weight and the slow response of its communications functions. The LW–Manchu system was reduced in weight, glitches in the CPU were repaired, and wearability and functionality were improved (TCM–S, 2010). Lastly, the system's success with the 4–9 Manchus during Operation Iraqi Freedom in 2007–2008 breathed life back into the system that the Department of Defense (DoD) cut from the FY2007 budget. The system has proved itself useful many times since the return of the Manchus. To date, the system has been deployed to Iraq and Afghanistan, two very different theaters of operation, with four separate Stryker brigades.

B. AN ABBREVIATED HISTORY OF THE NETT WARRIOR SYSTEM

After nearly 20 years of development and several combat deployments to both Iraq and Afghanistan, the LW has evolved into the NW, the latest system to integrate ground soldiers into a digitized network. The system's "mission is to provide unparalleled situational awareness (SA) and understanding to the dismounted leader

(team leader [TL] and above), allowing for faster, more accurate decisions in the tactical fight and connecting the dismounted soldier to the lower tactical network" (Beidel, 2010). It includes a hands-free display to view information, a computer to process information and populate the screen, an interface device for user-screen interaction, a system power source, a software operating system for system functionality, tactical applications and battle command, and a networked radio transmitter/receiver to send and receive information and voice communications (Frenchick, 2011).

NW has gone through several configuration changes from the once bulky and heavy system known as the Land Warrior Initial Capability (LW–IC) system. Initially, the system weighed a formidable 41 pounds. Eventually, it was stripped down to 10 pounds by Stryker soldiers of the 2nd Infantry Division's 4–9 IN, trained and deployed with the LW–Manchu system from 2006 to 2008. "Manchu" is the nickname the 4–9 Infantry regiment earned after they marched 85 miles across China (from Taku Bar to Tientsin) during the Boxer Rebellion that took place in 1900, during China's Manchu Dynasty (Kramer, 2009).

Upon redeployment, the LW–Manchu system was transferred to 5/2 SBCT so they could conduct familiarization training with the system. 5/2 SBCT received the updated version of the LW system just before deploying to Afghanistan and, subsequently, renamed it the LW–Strike. The system came in two configurations: the 7.28-pound team leader (TL) configuration and the 9.9-pound squad leader (SL) configuration. Additional upgrades to the LW–Strike system included software corrections to address the high number of system failures identified during the Manchu's deployment, to improve the functionality of the navigational subsystem (NSS), and to implement the Army's decision to use a commercial GPS. According to the Office of the Director, Operational Test & Evaluation (DOT&E, 2009), the system was fielded and deployed to Operation Enduring Freedom (OEF) with 5/2 SBCT in 2009 and redeployed in July 2010. In July 2010, 5/2 SBCT transferred its LW–Strike system to the 2nd Stryker Cavalry Regiment (SCR), who used it during its year-long deployment in Afghanistan. When 2nd SCR redeployed, it handed the system off to 1st SBCT, 25th Infantry Division (1/25 SBCT), Fort Wainwright, AK, in November 2010 (Duval, 2010).

The LW program is unique because in FY2007 the DoD cut the program from its budget (DoD, 2007). Based on historical precedent, the program should have ended then. As the Manchus were training to deploy to Iraq as part of President Bush's "surge" effort to fight al-Qaeda's development of safe havens, the procurement of the system halted. The Manchus had integrated the LW system so effectively into their battalion that to change their current techniques, tactics, and procedures would have meant retraining an entire battalion well into their deployment. This assessment caused the Senate Armed Services Committee to authorize $80 million in funds to equip 4–9 IN and two additional battalions. This effort allowed 4/2 SBCT to use the LW system at the brigade level during its deployment to Iraq in 2007 (see Figure 4).

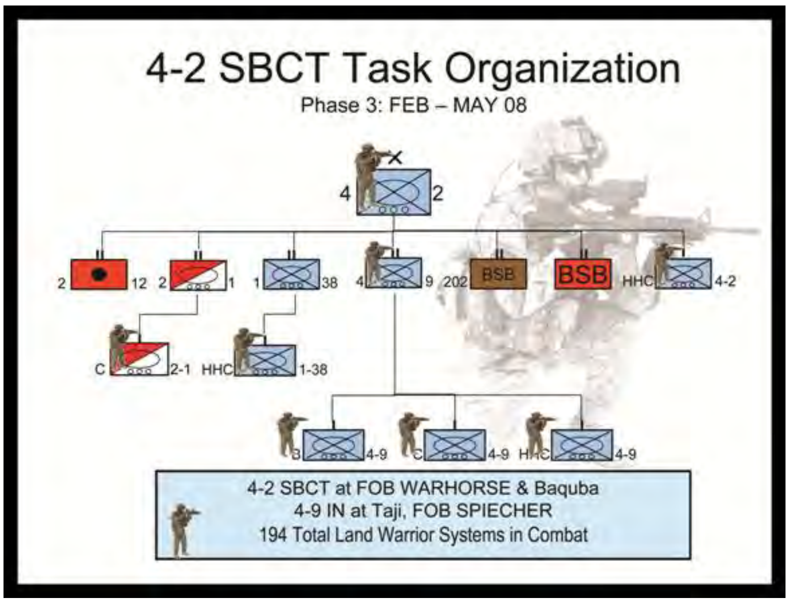

Figure 4. 4/2 SBCT Task Organization With Land Warrior-Equipped Units
(TCM–S, 2008)

The latest iteration of this system is called the Nett Warrior. Originally known as the Ground Soldier Ensemble (GSE), its official name is Ground Soldier System Increment I (GSS Inc I; Lopez, 2010). According to the DOT&E (2010), on the Army's birthday in June 2010, the GSE was formally renamed the Nett Warrior in honor of World War II Medal of Honor recipient, Colonel Robert Nett (DOT&E, 2010). The NW system is designed to fit under the back flap of the outer tactical vest (OTV) to reduce its profile so it is not visible to the enemy. It should add only five additional pounds to the OTV's weight. In addition, the new system has a battery designed to run for 24 hours on

a four-hour charge. These two new features give this system potential that far exceeds that of its LW predecessor (Lopez, 2010).

C. ORIGINS OF SOLDIER AS A SYSTEM

TRADOC's pamphlet 525–97 (2006) discusses the role the individual soldier plays on the battlefield:

> [The] individual Soldier remains the ultimate weapon on the battlefield, technology enables the [Brigade Combat Team] to understand, shape, engage, consolidate, and transition to control and win the next battle. Casualties and collateral damage are minimized, while operational success is expedited. The individual Soldier is not only a common factor in all battlefield functions, but central to future formations in all combat environments or scenarios. No battlefield function can occur without direct or indirect involvement of Soldiers. The [Soldier as a System] SaaS will support all current and future Soldiers, regardless of their role or mode of entry into the battle, and once there, will make Soldiers more efficient and effective, as well as more lethal and survivable. (p. 18)

The concept of the SaaS developed as leaders in the Army began to realize that there was a lack of integration between soldiers, their equipment, and the Army's other warfighting systems. The Army determined this disconnection was due to a lack of information-requirements integration with the combat developers and also to the materiel development community's "lack of configuration, manpower and personnel integration, and control of Soldier Items" (TRADOC, 2006, p. 4). The result was equipment and systems that were often bulky and heavy, which did not effectively meet soldiers' performance needs. Additionally, the Army lacked a holistic view of combat and materiel development. Soldiers in military occupational specialty (MOS) jobs that required combat, especially Armor and Infantry, received modernized equipment. On the other hand, soldiers in combat service support and combat-support MOS jobs did not receive the same attention. The goal of SaaS is to ensure the Army funds a minimum level of soldier capability across the Army, not just in the combat arms (TRADOC, 2006, p. 5).

To meet this need, the Army established the Program Executive Officer (PEO)–Soldier at Fort Belvoir, VA, to develop, produce, field, and sustain everything a soldier wears and carries.

PEO–Soldier's (2011) webpage explains their link between soldiers, their equipment, and the Army's systems:

> Program Executive Office (PEO) Soldier was created by the Army with one primary purpose: to develop the best equipment and field it as quickly as possible so that our Soldiers remain second to none in missions that span the full spectrum of military operations. … By viewing the Soldier as part of an integrated system, PEO Soldier ensures that the Soldier and everything he or she wears or carries works together as an integrated system. … In this respect, PEO Soldier is at the vanguard of Army transformation.

PEO–Soldier supports the acquisition of integrated soldier systems like the LW and NW programs through the Project Manager Soldier Warrior (PM SWAR). PM SWAR's goal is to "equip Soldiers with the best products the industry has to offer" (PM–SWAR, 2010). The result is a technologically advanced system that overmatches the enemy in terms of range and lethality, while reducing the load on the soldier (PEO–Soldier, 2011).

The Army achieves these goals by addressing soldier issues as they relate to Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, and Facilities (DOTMLPF). DOTMLPF is a problem-solving construct for assessing current capabilities and managing change. Change is achieved through a continuous cycle of adaptive innovation, experimentation, and experience. Change that is deliberately executed across DOTMLPF elements enables the Army to improve its capabilities to provide dominant land power to the joint force (DA, 2005b).

The TRADOC (2006) pamphlet 525–97, *Soldier as a System*, explains the following:

> Two considerations drive this process—one is threat based, the other capability based—to fix unidentified Soldier gaps. Where the Army met or exceeded weapons overmatch, based on opposing threat weapons, it based its modernization program on technology capabilities to widen its advantage. The Soldier is the Army's most vulnerable asset and is susceptible to almost every threat known on the battlefield. The primary consideration for any analysis of the Army's present Soldier capabilities will be based on the threat to the individual Soldier. (p. 19)

The LW's sub-meter imagery capabilities and GPS allow LW-equipped soldiers to navigate more proficiently. In addition, soldiers are better able to plan, coordinate and synchronize maneuvers internally and with adjacent units. LW icons also appear on the Force XXI Battle Command Brigade and Below (FBCB2) systems of vehicles equipped with a vehicle integration kit (VIK). This allows the unit leadership to track soldiers as they move on the ground (TCM–S, 2010).

C. NETT WARRIOR EMERGES

Similar to LW, the NW will be composed of a digital radio, a GPS beacon, and a wearable computer. Complete with a faster and more powerful processer and an expanded memory for storing maps, imagery, and graphics, NW has incorporated technological advances that improve its performance and reduce its weight. In addition to software developments and internal improvements, the current NW system has made significant ergonomic and functionality enhancements. Improvements targeted the enhanced Soldier Control Unit (eSCU) by making it a more user-friendly handheld controller with push-to-talk buttons and two radio channels, all thumb operated. Additional features new to the design are a QWERTY keyboard for text messaging and report/orders writing. The battery compartment was enhanced with the ability to carry single or dual batteries, allowing for longer mission times between changing out, and the use of quick-charging, rechargeable batteries. The optical display maintains the hands-free HMD but has an upgraded high-resolution 17-inch monitor equivalent.

These changes to the design and wearability are the results of four years of LW deployments to both Iraq and Afghanistan. The latest LW version weighed 10 pounds but the NW is said to weigh seven pounds and operate for 24 hours on a single, four-hour charged battery.

PEO–Soldier (2011) discusses how NW will employ a system-of-systems approach:

> The NW program will focus on the development of the SA system, which has the ability to graphically display the location of an individual leader's location on a digital geo-referenced map image. Additional soldier and leader locations are also displayed on the hands-free digital display. NW is connected through a secure radio that will send and receive information from one NW to another, thus connecting the dismounted leader to the

> network. These radios will also connect the equipped leader to higher echelon data and information products to assist in decision making and situational understanding. Soldier position location information will be added to the network via interoperability with the Army's Rifleman Radio capability. All of this will allow the leader to easily see, understand, and interact in the method that best suits the user and the particular mission. (PEO–Soldier, 2011)

In 2009, the Army awarded cost-plus-fixed-fee (CPFF) contracts to three government contractors in order to build NW prototypes: General Dynamics, Raytheon, and Rockwell Collins (Gould, 2010). Aided by lessons learned from past deployments of LW, each of the three contractors developed slightly different systems with unique characteristics. However, the main focus of the system down-selection, which was originally scheduled for February 2010 but has yet to be executed by the Army, is the improvement of all the contractor-furnished property (CFP) components. As illustrated in Figure 5, the government provided the contractors the radio, battery, and software, which focus them more on the technological aspects of the system (DOT&E, 2010). The NW body subsystem is designed to fit under the back flap of the improved outer tactical vest (IOTV) to reduce its profile so it is not as visible to the enemy as its predecessor, the LW-Strike, illustrated in Figure 6.

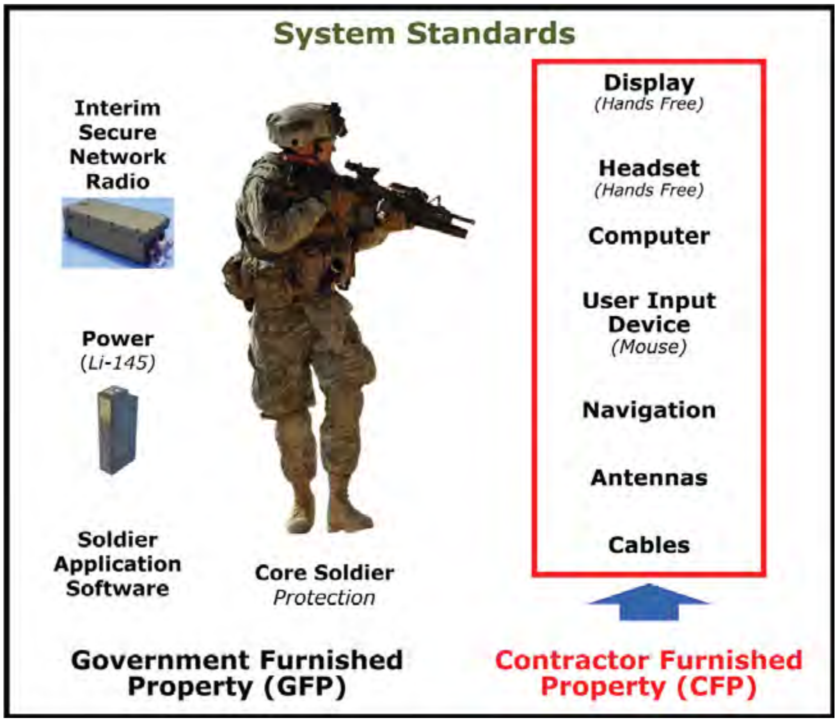

Figure 5. Nett Warrior Increment 1
(DOT&E, 2010)

Figure 6. Land Warrior–Strike 2009, Squad Leader Configuration, 9.94 Pounds
(TCM–S, 2010)

Overall, the NW body subsystem should add only five additional pounds to the IOTV's weight (Lopez, 2010). All three contractors were challenged to deliver a

prototype that weighs less, uses fewer batteries, and takes up less space on/in the IOTV. Throughout the life of the program, excessive weight and battery consumption have been the system's Achilles' heel. If contractors can overcome these main stumbling blocks it would prove a huge victory for the soldier who has to carry it.

Little is known about the NW system configurations developed by the three vendors because they are close hold as competition is ongoing. Figure 7 shows a concept as envisioned by Rockwell Collins. Shown in this picture are the helmet-mounted and chest-mounted HMD, the eSCU, and radio on the vest.

Figure 7. Rockwell Collins Nett Warrior Concept
(Ackerman, 2010)

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III. NETT WARRIOR USERS' PERSPECTIVES

> We are right on the cusp of solving some of the limiters that have been haunting us since the end of World War Two.
>
> – Colonel James G. Riley, TCM–S (2009, p. 7)

A. INTRODUCTION

In this chapter we briefly describe the Army TRADOC Capability Manager's (TCM) role in the acquisition process. We provide details about TCM–Soldier's (TCM–S) role in LW's development, equipping, and deployment. Also, in this chapter we present the outcomes of the 4–9 IN DOTMLPF ITA, the 5/2 SBCT DOTMLPF ITA, and other assessments that ultimately contributed to the development of the NW system.

In the Army's system acquisition process, the TRADOC Capability Manager, Training and Doctrine for the Soldier (TCM–S) is the user's representative for NW. TCMs are established to be the user representative during the acquisition process. As the former lead for TCM–S, Colonel Riley completed the majority of his TCM–S service during deployment of the 4–9 IN (Manchu), 4/2 SBCT to Iraq in 2008 and during the preparation phase leading up to 5/2 SBCT's deployment to Afghanistan in 2009.

As the lead for TCM–S, Colonel Riley was an advocate of the LW system and the innovative capabilities it placed in the hands of the ground fighting soldier. TCM's position was that the LW system was an effective combat multiplier. Colonel Riley supported the practice of setting the basis-of-issue plan (BOIP) at the TL level. He embraced the notion that every soldier was a sensor capable of making timely and prudent decisions. Furthermore, TCM–S felt compelled to ensure that the LW system was documented during its first-ever deployments to Iraq and Afghanistan.

Devoted to the mission of documenting how the LW–Manchu system performed in combat, Colonel Riley deployed members from TCM–S to conduct a DOTMLPF ITA to both theaters of operation, Iraq and Afghanistan. The purpose of the 2008 4–9 IN ITA, was to supplement TRAC–WSMR's 2007 DOTMLPF assessment that informed the Milestone C decision in 2007 (TCM–S, 2008).

A year later, TCM–S deployed to Afghanistan to conduct a subsequent supplementary analysis of the LW–Strike system's performance in Afghanistan while deployed by 5/2 SBCT "Strike" Brigade. Based on the results of both DOTMLPF ITAs, TCM–S concluded that the LW–Manchu system effectively mitigated 17 of the 19 small-unit capability gaps identified by the United States Army Infantry Center (USAIC) and TRAC–WSMR in the 2007 LW–Manchu Phase I Analysis of Alternatives (AoA). These gaps were identified during the functional needs analysis, based on a combination of operational lessons learned, USAIC student surveys, subject matter expert input, and experimental results. The results of the ITAs also concluded that the LW–Manchu system enabled leaders with precise navigation, mitigated fratricide, and allowed for the use of collaborative and more sophisticated tactics, such as the application of the digital chemlights (TCM–S, 2008). Below is a comment from one of the soldiers in 4–9 IN on the chemlight capability:

> The digital chemlight enabled leaders to display precise locations for direct and indirect fires while synchronizing movements of LW units. The digital chemlight was often used to designate waypoints and points of interest while on the move. LW lessens the burden upon subordinate leaders to periodically report their locations to higher headquarters, thus allowing leaders to focus on controlling their elements. The qualitative surveys demonstrated leaders were more actively controlling their units. (TSM–S, 2008, p. 6-2)

B. TRADOC CAPABILITY MANAGER–SOLDIER

In accordance with the 2005 Base Realignment and Closure Commission, Fort Benning, GA, serves as the United States Army's Maneuver Center of Excellence (MCoE). The mission of the MCoE is to provide the nation with the world's best trained infantry, armor, and cavalry soldiers. In addition to developing adaptive leaders instilled with the warrior ethos, Fort Benning serves as the home of TCM–S (TCM–S, 2010). TCM–S serves as the representative for the user community regarding anything that the soldier uses, is equipped with, or comes into contact with.

According to the TCM–S's website, its mission is as follows:

> To ensure modernization of the Soldier as a system of systems with the best possible equipment and associated doctrine, training, leader

development and fighting organization to fight and win in the contemporary operating environment. TCM–Soldier is the user's representative and the conscience of the Army for the Soldier—all Soldiers —within Army formations; and ensures DOTMLPF integration of Soldier capabilities across and within Army formations. (TCM–S, 2011)

The organizational chart for TCM–S is depicted in Figure 8. It shows the areas of emphasis regarding the soldier's requirements.

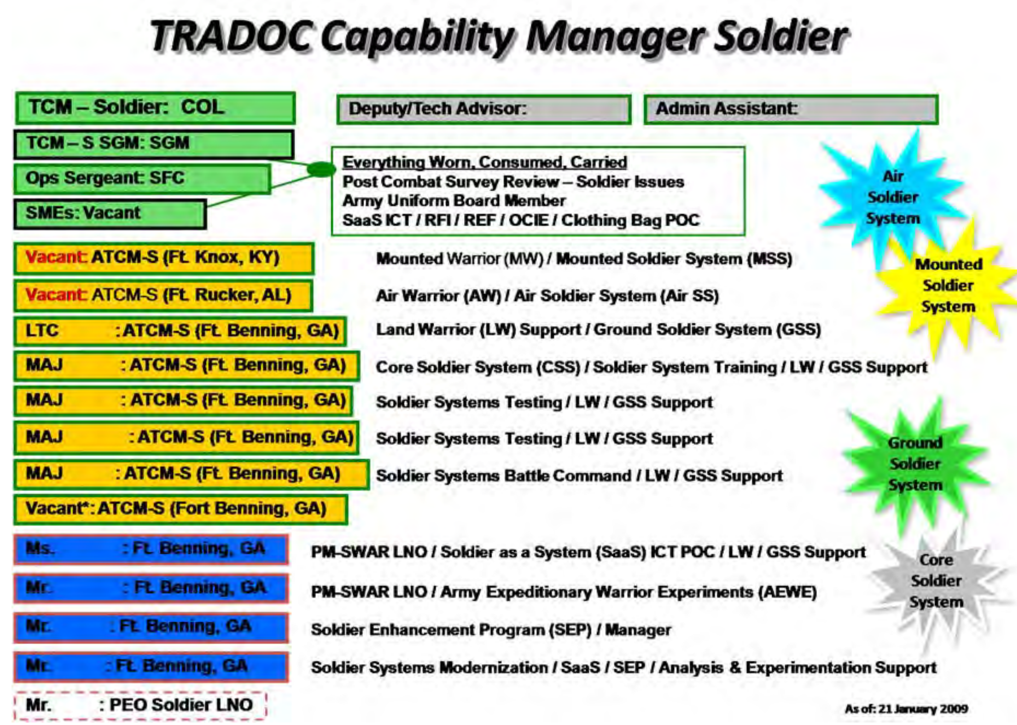

Figure 8. TRADOC Capability Manager–Soldier Organizational Chart
(TCM–S, 2011)

C. TCM–SOLDIER AND SOLDIER AS A SYSTEM

While the Armor Center and Army Aviation Center focused on the development of the Mounted Soldier System and the Air Soldier System, respectively, TCM–S focuses on the needs of the core and ground soldier systems. These efforts support the philosophy that the soldier's equipment should be modular in order to meet mission requirements.

In its 2011 resolutions, the Association of the United States Army (AUSA) details the Soldier as a System (SaaS) concept in its legislative agenda titled 11-15 Soldier Modernization:

SaaS takes a systems engineering approach that is integrated, and provides a modular solution. SaaS integrates more than 400 unique items of equipment, providing increased combat effectiveness for our Land, Mounted and Air Warriors while reducing size, weight, and power requirements. The modern battlefield requires this integrated and packaged approach to improve the individual Soldier's lethality, survivability, command and control, situational awareness, sustainability, mobility, and combat effectiveness. Critical elements include: the Soldier Enhancement Program (SEP) and the Rapid Fielding Initiative (RFI) for the near-term non-developmental items; modular improvements for mid-term solutions; and Nett Warrior, Air and Mounted Soldier programs for the long-term solutions. (Association of the United States Army [AUSA], 2010, p. 1)

In Figure 9, the four components concerning the SaaS Strategy for Soldier Modernization are depicted.

Figure 9. Soldier as a System Strategy for Soldier Modernization
(TCM–S, 2010)

As first mentioned in Chapter II, the purpose of the SaaS concept is to support the Army's vision that soldiers remain the centerpiece of our combat systems and formations. The Army's vision statement further supports the idea that soldiers should remain the

crucial link to both realizing FCS capabilities and enhancing the effectiveness of current forces (TRADOC, 2006).

In S. L. A. Marshall's (1980) *The Soldier's Load and Mobility of a Nation*, we see the importance of identifying the complete soldier and defining those systems in concert in order to ultimately increase the soldier's overall effectiveness and efficiency. From World War I through the Vietnam War, the soldier's load did not change significantly in terms of weight. Only gradually have items been improved or made of lighter materiel, as with the Vietnam-era load bearing equipment. As technology continues to improve, so does our threat to national security; and in spite of using lighter materials to manufacture personal equipment, battlefield requirements have continued to grow, often causing the soldier's load to exceed 100 pounds.

In keeping with the 1991 Army Science Board (ASB) summer study that identified the need for the Army to manage the soldier's load, the SaaS Integrated Concept Team (ICT) continues to refine soldier requirements. Designated by TRADOC, MCoE at Fort Benning, GA, is the proponent for SaaS and the concept development within the DOTMLPF framework. TCM–S has taken a holistic approach to the requirements. The TCM–S underlying approach was to equip the soldier modularly with the equipment that best suited the needs of the mission (Lockhart, 2006).

D. TRADOC CAPABILITY MANAGER–SOLDIER & NETT WARRIOR DEVELOPMENT

TCM–S has a long history of serving as a steadfast proponent for the LW and NW programs. Under the guidance of HQDA and the MCoE, the materiel developer and TCM–S have pursued dismounted battle command systems to fill the operational capability gaps of the ground fighting soldier. Although several similar systems have been developed, TCM–S's position has been that the NW and LW systems were most capable of filling the ground soldier's 19 capability gaps (TCM–S, 2010).

Within the past decade, several systems have been developed that provide capabilities similar to those of the LW. In 2003, due to concerns surrounding the cost and reliability of the LW system, the Army explored alternative materiel solutions. During

that year, General Dynamic's subsidiary, GDC4S, developed a prototype called the Dismounted Battle Command System (DBCS). DBCS was a handheld device, similar to today's tablets, and it met most of the LW–Manchu requirements. Unlike the LW–Manchu, it was leadership-focused instead of soldier-focused. At that time, Colonel Ernie Forrest from TCM–S voiced his concerns about the BDCS. He wanted to focus on the LW–Manchu-based capabilities, such as lethality, the weapon subsystem (WSS), and the basis of issue (BOI; Clifton & Copeland, 2008).

This direction was also more aligned with Joint Vision 2020, specifically, its recommendation that the Services "have the embedded technologies and adaptive organizational structures that will allow trained and experienced people to develop compatible processes and procedures, engage in collaborative planning, and adapt as necessary to specific crisis situations" (Chairman of the Joint Chiefs of Staff [CJCS], 2000). The LW–Manchu system and the DBCS both provided information superiority beyond the capability of unequipped soldiers, allowing for dominant maneuverability on the battlefield. TCM–S's stance was that the LW–Manchu system allowed soldiers' hands to remain on their weapons, adding lethality and force protection measures to the equation (Clifton & Copeland, 2008). In addition to the DBCS, several other options were developed. However, the LW and NW remained TCM's systems of choice because they continued to be the systems most capable of fulfilling the ground soldiers' requirements.

E. LAND WARRIOR AND THE 4–9 INFANTRY IN IRAQ

In April 2007, the 4/2 SBCT had the distinction of being the first Stryker brigade to deploy with all ten Stryker variants as part of the surge. For the next 15 months, the 4–9 IN operated out of Camp Taji while conducting full-spectrum operations aided by the LW–Manchu. During the first 12 months of 4–9 IN's deployment, TCM–S conducted a DOTMLPF ITA of the 4–9 IN's application of the LW–Manchu system. The purpose of TCM–S's ITA was to supplement findings in the 2007 TRAC–WSMR Land Warrior (LW)/Mounted Warrior (MW) DOTMLPF assessment. The results of this report would inform the March 2007 LW–Manchu Milestone C decision (TCM–S, 2008).

According to the October 2008 ITA report, TCM–S's analysis found that equipping the 4–9 IN with LW–Manchu down to the TL level greatly enhanced its force effectiveness in terms of mission success, lethality, and operational tempo. The rifle team is the smallest maneuver element in the fight. While equipped down to the TL with the LW–Manchu system, the 4–9 IN captured twice as many targets as any other battalion within the brigade, equating to 48% of the brigade's total. These results are illustrated in Figures 10 and 11. LW–Manchu-equipped mission times were reduced by 26% compared to non-LW equipped units during time sensitive target (TST) missions. LW–Manchu enabled precise navigation, fratricide mitigation, collaborative operations, and the advent of digital chemlights and breadcrumbing. Both of these tactics allowed for greater situational awareness and faster decision-making up and down the chain of command (TCM–S, 2008).

Unit	ToT Targets	Captured	% Captured	HVIs Captured	ToT % HVIs Captured
1-38 IN	324	53	16%	10	8%
2-1 CAV	324	30	9%	11	8%
2-12 FA	324	45	14%	27	21%
TF 4-9	324	143	44%	63	48%
Others	324	53	16%	19	15%
SUM		324	100%	130	100%
AVG (BN)		65	20%	26	20%

Figure 10. Percentage of Captured High Value Individuals by Battalions
(TCM–S, 2008)

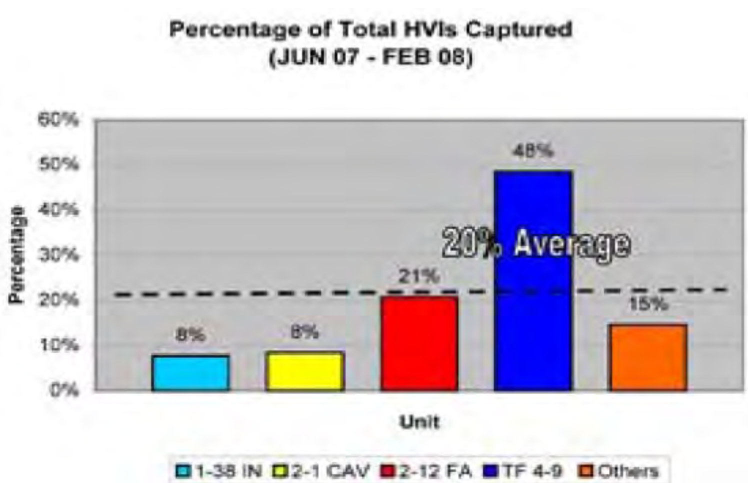

Figure 11. Percentage of Total High Value Individuals by Land Warrior–Manchu-Equipped Units (TCM–S, 2008)

The soldiers in the 4–9 IN greatly benefitted from the robust Enhanced Position Location Reporting System (EPLRS) network organic to the Stryker brigade. Equipped with a VIK, the Stryker vehicles accurately tracked the locations of dismounted LW–Manchu systems on the battlefield and coordinated maneuvers that effectively supported dismounted squads. The enhanced SA afforded the Stryker mounted elements better coordination in supporting the efforts of their dismounted soldiers. For the first time in an operational setting, mounted ground forces had real-time SA of the location of friendly forces on the battlefield.

> A LW vehicle integration kit (VIK) was installed on all Stryker vehicles carrying LW equipped Soldiers to provide connection to the lower tactical internet (LTI) and [a] battery recharger. The VIK comprised a battery charger, a battery storage unit, and a vehicle gateway. (TCM–S, 2008, p. 1-5)

While equipped with the LW–Manchu system, the 4–9 IN performed a variety of operations, including serving as the brigade's primary high value target (HVT) raid team. Although many of the operations the 4–9 IN conducted in Iraq allowed for mutually supporting efforts between dismounted and mounted operations, the Manchus also performed air assault missions during some of their HVT raids. Aided by enhanced SA and precise navigation, the LW–Manchu-equipped soldiers maneuvered with more confidence and speed on the unfamiliar terrain that is often associated with HVT raids. "Land Warrior [Manchu] gave me confidence as I planned to coordinate for a blind hit at night for the first time in this area," said the 4–9 IN fire support officer, who used the LW–Manchu with the 4th BN (PEO–Soldier, 2009).

In a June 2009 article in *Soldier Modernisation,* Colonel Riley, former TCM–S, stated that the LW–Manchu's enhanced capabilities allowed fire team leaders to make better informed decisions:

> We are going to give fire team leaders Situational Awareness (SA). Within that, the fire team leaders have a display which shows [them] maps and imagery to give [them] an idea of what's going on. Every leader starts by asking some very basic questions. The first is "Where am I?" It is pretty significant to know where you are. However, that didn't come out much in training; in fact we never saw it to be that big a deal in test and evaluation. Nevertheless, once you get into unknown country and [it's] dark out,

> knowing exactly where you are at any one moment is pretty important. (Riley, 2009, p. 7)

Colonel Riley's position was that the LW–Manchu system provided unparalleled enhancements to the ground fighting soldier in terms of SA, precise navigation, and improved battle command.

After 12 months of observation during the 4–9 IN ITA, TCM–S (2008) noted that the enhanced force effectiveness of the LW–Manchu system was remarkable. The LW–Manchu system allowed 4–9 IN leaders to make better informed battlefield decisions and to rapidly and clearly direct the actions of their subordinates. As a result, those subordinates responded more quickly than their adversaries and dominated the small unit counter-insurgency fight (TCM–S, 2008).

Another observation indicated the power of digital chemlights, digital icons that LW–Manchu users can populate and label for other users to see. The soldiers of 4–9 IN developed a standard operating procedure (SOP) for the use of the four different-colored digital chemlights and were creative in applying this new feature. Soldiers from 4–9 IN also used the digital chemlight to generate a grid system for searching open fields. In addition, they used the digital chemlight to mark suspected or known enemy positions (TCM–S, 2008).

In Colonel Riley's (2009) quote, he provided an example of how the digital chemlight allowed ground and mounted forces to exploit their enhanced SA.

> A squad entered the objective and took fire from a sniper location. They quickly marked that point with the digital chemlight which focused the [organization] on that location. Their Stryker vehicle knew that, even though they didn't have a field of fire. That C2 piece for small unit leaders allows you [team leader] to focus combat power very quickly (p. 8).

In addition to marking buildings, digital chemlights were used as a grid reference system. Figure 12 shows Objective (OBJ) Taft, a clearance operation in Operation Iraqi Freedom (OIF) that the 4–9 IN conducted. As you can see in the illustration, two squads cleared a palm grove searching for hidden caches of weapons and Improvised Explosive Device (IED)-making devices. An advantage to this grid reference system was that the leadership were able to follow the squad's progress without being updated by the

leadership. This technique facilitates stealth movement, aiding noise and light discipline (T. Qualls, personal communication, July 28, 2011).

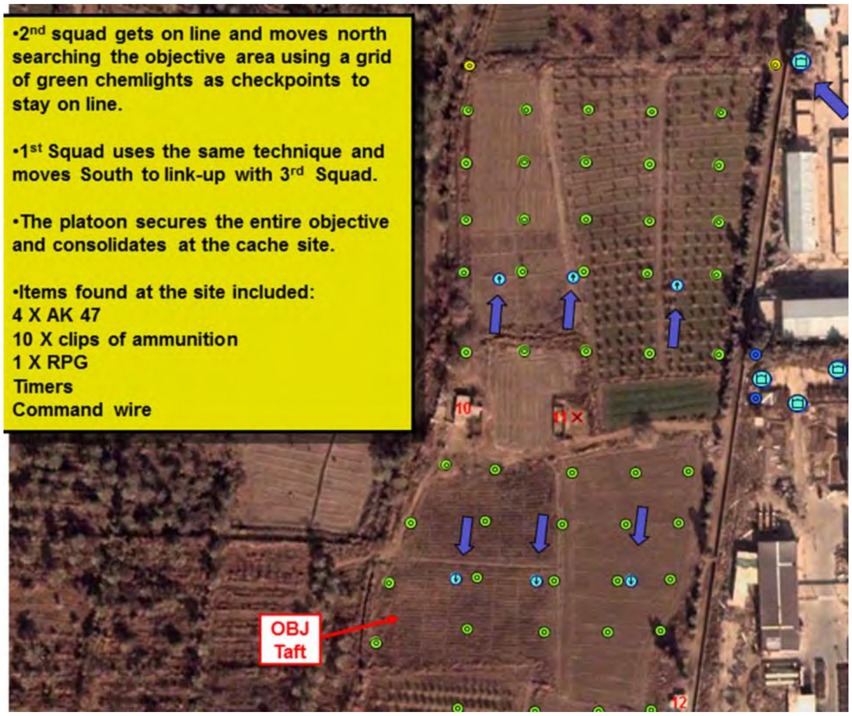

Figure 12. Objective Taft, Clearance Operation
(Qualls, 2011)[2]

F. LAND WARRIOR–STRIKE AND 5/2 SBCT IN AFGHANISTAN

After the 4–9 IN redeployed from Iraq, a majority of their LW–Manchu systems were sent to the 5/2 SBCT to begin familiarization training in October 2008. Equipped with 100 LW–Manchu systems, the brigade rotated squads through situation training exercise (STX) lanes from October to December 2008. Following the three months of familiarization training, the 5/2 SBCT executed their National Training Center (NTC) rotation in January 2009. During its NTC rotation, one company per battalion was equipped with the LW–Manchu system. Due to factors beyond the control of the unit and the PM, the 5/2 SBCT finally received its LW–Strike systems in May 2009, two months prior to its deployment to Afghanistan. With only two months to conduct new equipment

[2] Lieutenant Colonel Ted Qualls, Assistant TCM–Soldier, provided the vignette for OBJ Taft to illustrate the digital grid reference SOP developed by the 4–9 IN.

training (NET), the unit had a compressed timeline to conduct final training and pre-deployment activities (W. Hiatt, personal communication, October 22, 2011).

In July 2009, the 5/2 SBCT earned two distinctions. The 5/2 SBCT was the first Stryker brigade to deploy to Afghanistan. Second, it was the first LW-equipped unit in Afghanistan. The 5/2 SBCT received an updated LW system, referred to as the LW–Strike system, in honor of its brigade. The LW–Strike system was modified from its predecessor based on user feedback from 4–9 IN. The system came in two configurations: the 7.28-pound TL configuration, and the 9.9-pound SL configuration. Upgrades to the system included software corrections to address the high number of system failures identified during the Manchu's deployment, an NSS, a text pad on the soldier control unit, a Peltor noise-cancelling headset with a band behind the neck as opposed to over the crown of the head, and a commercial GPS (TCM–S, 2010).

In August 2009, TCM–S deployed a team to Afghanistan to conduct an ITA with the 5/2 SBCT. The 5/2 SBCT ITA spanned from August 2009 to March 2010, as shown in Figure 13. The purpose of the 5/2 SBCT ITA was to observe the impacts of the LW–Strike system in Afghanistan and to supplement the findings of the 4–9 IN ITA. During the 5/2 SBCT ITA, the MBL out of Fort Benning, GA, conducted two surveys (TCM–S, 2010).

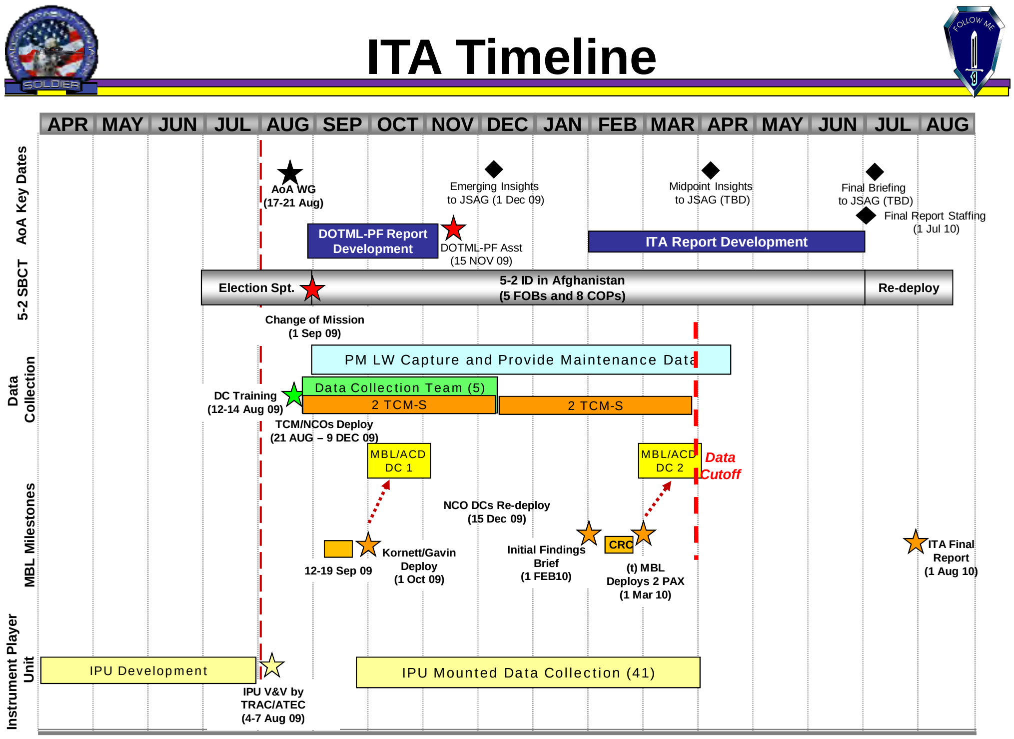

Figure 13. Land Warrior Assessment Team Timeline, 2009/2010
(TCM–S, 2010)

After conducting familiarization training with the 4–9 IN Manchu systems, completing a mission-ready exercise (MRE) at the NTC with the LW–Manchu systems, and conducting NET with the LW–Strike systems, TCM–S initially thought that 5/2 SBCT was adequately prepared for its deployment to Afghanistan (TCM–S, 2010). However, two surveys conducted by the MBL during the deployment revealed that 5/2 SBCT had inadequate opportunities to conduct collective training with its newer LW systems due to time constraints.

According to the MBL, the 5/2 SBCT lacked sufficient training opportunities to develop user acceptance and proficiency prior to deploying:

> New equipment training was sufficient to introduce the unit to the LW system. However, Soldiers did not receive an opportunity to embrace the added capabilities prior to deploying. After NET, there were no further opportunities to collectively exercise the system and embrace the enhanced capabilities. Prior to the MBL survey, TCM–S assumed there would be a learning curve with user acceptance and proficiency with applying functions. Between the two surveys (October 2009 and March 2010), the MBL concluded that user acceptance and proficiency with the

> system improved with additional time using the system. The ITA revealed that during the initial survey, LW users reported that LW most impacted two tasks: navigation and understanding friendly locations. Surveys concluded that user acceptance and proficiency with the LW–Strike system is directly related to the amount of time Soldiers have to apply the system in collective exercises. Not having ample opportunity to conduct collective exercises with the system prior to entering into combat operations affected user acceptance and proficiency to apply the system. (TCM–S, 2010, p. 2-2)

Once in Afghanistan, TCM–S observed how each battalion operated in a different manner according to the threat and terrain. Some battalions operated more in the manner of an Infantry Brigade Combat Team (IBCT) in which Stryker vehicles are not employed to mutually support the dismounted maneuvering elements. These battalions used this method because they needed to be stealthier or more compliant to concessions made with local village leaders. Other battalions performed more in the manner of traditional cavalry screening operations and did not dismount as often because they needed long-range surveillance and maneuverability over vast expanses of terrain (TCM–S, 2010).

Although reaping the benefits of enhanced SA, LW–Strike-equipped units faced other challenges with the system. For example, the system's weight and power requirements continued to pose significant challenges in the daily operations of each of the battalions within the brigade. Depending on the battalion's area of operation, the terrain in Afghanistan varied from mountainous with extreme elevation changes, to wide open desert, to dense orchards, such as those found in the Arghandab Valley. It was not uncommon for soldiers from various battalions to operate in a more traditional IBCT role, often operating for days without resupply. Soldiers would have to plan for several days' worth of supplies, including LW batteries. The added weight of the LW–Strike system (7.2 pounds), plus the additional weight of the batteries, required for a three-day operation (3 days x 3 batteries/day x 2.2 pounds/LI-145 battery) was a significant burden to the soldier (TCM–S, 2010).

The 5/2 SBCT ITA discusses how soldiers experimented with the LW–Strike's configuration in order to tailor the system to the operational requirements specific to each battalion:

> Three of the four battalions experimented with alternate configurations for the LW system. Normally, storing the LW system in the IOTV reduced the sitting area of Soldiers by two inches, adding to their discomfort by forcing them to sit at the edges of their seats. Soldiers were also unable to drop down in the Stryker hatches while wearing the LW system in the back of the IOTV with ammunition attached. Soldiers adopted several alternate methods for wearing the system: 1) the assault bag configuration using [a] [CamelBak] (4–23), the [IFAK] (1–17), and a pouch that easily attaches/detaches to the outside rear of the IOTV (2–1) and 2) a palm pilot that can easily be stored in the [Army combat uniform] ACU shoulder pocket, hangs the HMD from the chest and has the ability to invert the image to quickly view the screen; and a "quarterback" wrist display. (TCM–S, 2010, p. 4-5)

Soldiers from 1st Battalion, 17th Infantry (1–17 IN) developed a condensed configuration by storing the LW–Strike in an improved first aid kit (IFAK), as shown in Figure 14. This allowed the soldiers to carry the LW–Strike system in various locations on their IOTV.

Figure 14. Improved First Aid Kit Configuration Observed at 1–17 IN
(TCM–S, 2010)

Alternatively, soldiers from 8th Squadron, 1st Cavalry Regiment (8–1 CAV) and 2nd Battalion, 1st Infantry Regiment (2–1 IN) utilized a separate CamelBak bag to house the LW–Strike system in an assault bag configuration. By housing the LW–Strike system in an assault bag, the soldiers were able to move more freely within the Stryker vehicles and in some of the tight hatch openings. Prior to dismounting vehicles, soldiers simply grabbed their assault bag and executed the mission. The assault bag configuration also allowed soldiers to quickly detach the LW–Strike system prior to climbing over tall

walls, some in excess of 14 feet. Vehicle commanders also benefitted from the assault bag configuration, because the system's capabilities were adapted for mounted operations (TCM–S, 2010).

TSM–S also observed that the soldiers, most notably 8–1 CAV, adapted the LW–Strike system's HMD, worn by vehicle commanders, to meet mission needs. Leaders routinely reported that the LW–Strike system had a faster refresh rate than the BLUFORCE tracker system that is mounted in the Stryker vehicles. Utilizing the LW–Strike system in an assault bag configuration, vehicle commanders were better able to maneuver their Stryker vehicles due to the faster refresh rate and HMD. Vehicle commanders attached the assault bag that contained the LW–Strike system to the hull of the vehicle. The HMD from the LW–Strike system was then attached to the combat vehicle crewman (CVC) helmet, which allowed for commanders to stay in the hatch. This mitigated the requirement for commanders to drop down in the vehicle in order to get an update on their location and the operational environment (TCM–S, 2010).

Although not condoned by TCM–S, one battalion observed a technique to conserve battery power. With this battery-conservation technique, a designated TL did not power up his LW–Strike system in order to allow the SL to use the extra batteries. This technique presented several significant drawbacks. First, by not powering up all the available LW–Strike systems, the unit produced a less robust EPLRS network. Next, by not having all systems fully operational, leaders did not possess full awareness of friendly elements during the operation. Finally, the TL carried the additional weight of the system and extra batteries without benefiting from any of the system's technological capabilities (TCM–S, 2010).

Some soldiers modified how the system was employed, which was one of the other strengths noted by TCM–S. The LW–Strike system maintained enough flexibility to conform to the user's preferences. For example, 4–9 IN modified the original configuration that attached the system to the soldier's waist. Instead, the Manchus moved the system onto the back plate of the IOTV, which concealed the components and allowed for improved fit and functionality. We find it interesting that Colonel Cumming's quote in a June 2009 *Soldier Modernisation* article accurately predicted 5/2

SBCT's modifications to how soldiers would wear the system. Fundamentally driven by continuous feedback from soldiers, changes to the LW system resulted in the development of a suite of options. According to PM LW, "If you look at nine Soldiers, every one of those nine will carry their kit a different way which fits their unique requirements for how they do things and based off their form, fit, function, and feel" (Cummings, 2009, p. 8).

Some soldiers from 5/2 SBCT demonstrated their dislike towards the Peltor headsets of the LW–Strike. 4–9 IN was given a choice between Quiet Pro in-ear devices and Peltor headsets, but 5/2 SBCT received only the Peltor headsets. The Peltor headsets provided sound amplification as well as noise cancellation. Soldiers often reported their general dislike of the Peltor headsets. Overwhelmingly, soldiers reported discomfort and other problems caused by the Peltor headsets. The four major concerns were as follows:

> The Peltor headsets completely cupped their ears, causing increased discomfort from excessive sweating during the extreme heat of Afghanistan. Even during the winter months, Soldiers did not use the headsets. They were unable to employ the [cognitive radio network] CNRS digital radio of the LW Strike system. Ambient noise amplification was overwhelming while they maneuvered through areas with fallen brush. They were unable to locate the origin of sounds. (TCM–S, 2010, p. 4–5)

Overall, the Peltor headset was not well received by 5/2 SBCT soldiers in either hot or cold climates. Having no other headset options, soldiers either accepted the Peltors or chose not to wear them, forgoing the use of the CNRS digital radio as well (TCM–S, 2010).

After nearly nine months of observations of 5/2 SBCT, TCM–S confirmed the 2008 4–9 IN ITA's findings concerning the small unit capability gap. The 2010 5/2 SBCT ITA concluded that the LW–Strike system "filled or mitigated 17 of the 19 small unit capability gaps. All 13 leader tasks contained in the 19 unit capability gaps were filled or mitigated by LW [Strike]" (TCM–S, 2010, p. 6-1). This outcome is not surprising considering the similarities between the LW–Manchu and the LW–Strike systems. Figure 15 shows a side-by-side comparison of the ITA small unit capability gaps assessment of the LW–Manchu and LW–Strike systems.

Task	Small Unit Capability Gap	Group	4-9 ITA	5/2 ITA
1	Leaders gain and maintain SA/SU*	C2	Fills	Fills
2	Coordinate movements and fires of subordinate elements		Fills	Fills
3	Receive, process, and report tactical information		Mitigates	Mitigates
4	Receive and issue orders and instructions with overlays		Fills	Fills
5	Perform voice communications		Mitigates	Mitigates
6	Navigate dismounted as a small unit		Fills	Fills
7	Coordinate with adjacent units		Mitigates	Mitigates
8	Fight dismounted ICW armored vehicles		Fills	Fills
9	Direct dismounts from an armored vehicle		Mitigates	Mitigates
10	Kill or suppress Threat with indirect fires	Fire Support	Mitigates	Mitigates
11	Request and adjust fires from a Joint source		Mitigates	Mitigates
12	Conduct engagements with precision guided munitions		Mitigates	Mitigates
13	Conduct personnel and vehicle checkpoints	Close Fight Actions	Mitigates	Mitigates
14	Move under direct fire		Not filled	Not filled
15	Direct employment of smoke		Mitigates	Mitigates
16	Enter a building during an urban operation		Mitigates	Mitigates
17	React to man-to-man contact		GNF	GNF
18	Locate mines and booby traps		Mitigates	Mitigates
19	Kill Threat using direct fire		Mitigates	Mitigates

Fills Gap | Mitigates Gap | Does Not Fill Gap | Gap Not Filled by material solution

* Land Warrior provides the dismounted leader situational awareness, not situational understanding

Figure 15. Land Warrior–Manchu and Land Warrior–Strike Capability Gaps Assessment (TCM–S, 2010)

In summary, the 5/2 SBCT ITA confirmed the 4–9 ITA's findings that LW filled or mitigated the majority of the small unit capability gaps. The ITA assessment team reported that "Land Warrior [Strike] dramatically improved SA especially with recent, sub-meter imagery. Land Warrior [Strike] provided real-time updates of friendly and threat locations using standard military and user defined symbols, and operational graphics, geo-referenced to maps and/or imagery" (TCM–S, 2010, p. 6-2).

Although each battalion displayed their own varied levels of acceptance and developed unique carrying configurations, the LW system displayed its potential to be a feasible materiel solution in filling the small unit capability gaps. Ultimately, TCM–S contended that leaders made better informed decisions and executed tasks more efficiently while sharing a common operational picture (COP) though the use of the LW system (TCM–S, 2010).

G. 2ND STRYKER CAVALRY REGIMENT AND LW–STRIKE

In July 2010, the 5/2 SBCT transferred the LW–Strike systems to the 2nd Stryker Cavalry Regiment (2SCR), also known as the "Dragoons," during an in-theater relief in

place (RIP). The 2SCR then used the LW–Strike system during its year-long deployment in Afghanistan. The 2SCR conducted missions similar to the 5/2 SBCT's missions in the southern region of Afghanistan, centered on Kandahar. However, during this deployment, TCM–S did not conduct an ITA. Instead, TCM–S refocused its attention on the development of the next increment of the LW system, called the NW Increment I[3] (Geddes, 2011).

Upon the unit's redeployment from Afghanistan, TCM–SBCT and TCM–S conducted a post-deployment survey of 2SCR in Vilseck, Germany, July 11–15, 2011. The purpose of the post-deployment survey was to collect data and feedback on a variety of equipment utilized in Afghanistan, including the LW–Strike system. TCM–SBCT and TCM–S both received similar comments during their DOTMLPF assessments of the 2SCR. No significant changes were reported regarding doctrine and organization. However, the 2SCR reported two shortcomings in the areas of training and materiel. In regards to training, the 2SCR reported

> not receiving adequate training time on the LW–Strike system. Some units were able to use the system during the mission readiness exercise (MRE) but they were the fortunate ones. Other 2SCR squadrons reportedly had four days of instruction prior to deployment. (Maneuver Center of Excellence [MCoE], 2011a)

Other soldiers reported receiving no training at all prior to deploying, requiring training in theater to familiarize them with the system (MCoE, 2011b).

Inadequate training time and opportunities continue to be a recurring trend. In July 2009, Dr. Jean Dyer and Jennifer Tucker of the Army Research Institute (ARI) identified this problem in their report *Training Analyses Supporting the LW and Ground Soldier Systems* (Dyer, 2009). Dyer and Tucker reported that the LW–Manchu NET conducted for the 4–9 IN was assessed to be inadequate. Individuals reported that the NET was insufficient in terms of time, tasks addressed, training strategy, and method. Consequently, individuals were not fully trained to operate, maintain, and employ the system. The ARI's analysis recommended that company training time should double,

[3] We will refer to the NW Increment I as NW for simplicity for the duration of the paper.

increasing from nine days to 18 days. The new 18-day training schedule would include a collective training phase (Dyer, 2009).

Many of the ARI's findings were incorporated into the new training objective for the LW–Strike. Similar to the 5/2 SBCT's time constraints, the 2SCR could not implement the lengthy company training timeline due to lack of available time on an already full pre-deployment training schedule. Under ideal circumstances, the 2SCR would have received an adequate supply of LW–Strike systems six months prior to deployment. This would have allowed the unit to use the system during pre-deployment training events and, more importantly, during its MRE and increase unit buy-in (MCoE, 2011a).

Colonel Riggins, PEO–S, understands this comment more than anyone. Here are his comments in reference to training on the system:

> One thing we found was, this [LW] is not just something you hang on a Soldier and say, "Go ahead and fight," because it truly changes the basic methodology of how you fight, how you command and control and how you share information. (Gould, 2010)

The Dragoons of 2SCR never received training six months prior to deployment. At that time, 5/2 ID was still conducting combat operations in Afghanistan and limited quantities of the LW–Manchu system were available for use. The LW system is a leader-intensive piece of equipment that requires the concerted effort of any unit and its leaders to conduct NET. Because the 2SCR did not have enough systems to go around, training was slow and the Dragoons did not realize the unit buy-in they originally envisioned.

In terms of materiel, TCM–S reported that only one squadron effectively used LW–Strike during its deployment. However, the units that did not use the LW–Strike system still desired the SA and battle command capability at the SL and TL levels (MCoE, 2011b). TCM–SBCT received a comment of note regarding lethality of an infantry squad. One leader commented that carrying more equipment will not make the unit more lethal: "All this gear just slows us down" (MCoE, 2011a, p. 2). Reinforcing this leader's message, the 2SCR's concerns regarding lethality and effectiveness also focused primarily on the soldier's load: "Adding more capability equals adding more

weight. Until Soldier load has been reduced, any additional capability added must be careful[ly] measured to determine whether it is worth the increased weight" (MCoE, 2011a, p. 2). This remark has been echoed throughout TCM–S, sending a clear message that "every ounce counts." In addition to the LW–Strike system, soldiers in Afghanistan carried all of their other required personal protective equipment. This added weight and capability took a heavy toll on soldiers' endurance.

The 2SCR's comments centered heavily on LW–Strike's ability—or inability—to establish a robust EPLRS mesh network, depending upon the type of missions being performed. TCM–S received comments supporting the effective use of the LW–Strike system during dismounted missions of short duration and within a few kilometers of EPLRS-equipped Stryker vehicles.

Overall, similar comments were obtained from TCM–SBCT and TCM–S: Soldiers from the 2SCR were concerned with the overall soldier load and how the added capabilities increased the weight carried (MCoE, 2011b).

In order to suit its combat operational needs in Afghanistan, the 2SCR conducted a weight-to-capability analysis. The 2SCR's prevailing recommendation was to reduce the overall weight of the soldier load. The Dragoons wanted a more practical and portable system and felt the LW–Strike system just needed more refining (W. Hiatt, personal communication, October 22, 2011).

However, this does not mean that all of the soldiers disliked the LW–Strike system; instead, their responses to the system were highly mission specific. Captain Simone Wood, TCM–SBCT, noted the following in page 4 of her 2SCR lessons learned report:

> Feedback received about the Land Warrior system [Strike] was extremely dependent on where the unit was operating and what their mission set was. Units operating in static positions or in urban areas gave generally positive feedback, as they were able to get a good EPLRS signal, which allowed them to utilize the system fully. Units in rural, remote or mountainous regions had almost nothing good to say about it. (MCoE, 2011a, p. 4)

The 2SCR redeployed and transferred the system to 1/25 SBCT, Fort Wainwright, AK, in November 2010. As of this writing, the 1/25 SBCT is conducting combat

operations in Afghanistan and there is no available feedback on its use of the LW-Strike (T. Qualls, personal communication, July 28, 2011).

H. MANEUVER BATTLE LAB FINDINGS FROM LIMITED OBJECTIVE EXPERIMENT 2009

In 2008, the Army planned to begin fielding IBCT with the NW integrated with a Rifleman Radio (RR) capability in FY2012. In support of a directive from the Office of the Secretary of Defense (OSD) to update the AoA for NW, TRAC–WSMR recruited the support of the MBL to conduct an LW Limited Objective Experiment (LOE) from January 5 to March 20, 2009, at Fort Benning, GA. The purpose of the 2009 LOE was to assess the effectiveness of an Infantry small unit equipped with a surrogate for the NW capability, the LW–Manchu system. The LW–Manchu was used because it provided many of the NW capabilities (Maneuver Battle Lab [MBL], 2009).

The OSD was interested in comparing the operational effectiveness and life cycle costs of three alternative BOIPs to inform a NW Milestone B/C decision that was scheduled for the second quarter (2Q) of FY2011. The LW–Manchu system served as the surrogate for the NW Inc I,[4] the NW integrated with an RR capability. The following list identifies the three alternative BOIPs tested:

- Base case: a currently equipped unit with its modified tables of organizational equipment and rapid fielding initiative equipment;
- SL BOIP: NW distributed to the SL level and all others equipped with an RR capability (use of the LW–Manchu system minus the HMD; and
- TL BOIP: NW distributed to the TL level; all others equipped with an RR capability.

The MBL developed five force-on-force mission sets for the LOE with the coordination of the World Class Blue Force (WCBF), the TRADOC Intelligence Support Activity (TRISA), and one IBCT rifle platoon from the TRADOC Experimental Force (EXFOR; MBL, 2009). In preparation for the LOE, the EXFOR conducted two months of training in order to develop its proficiency as a currently equipped unit and with the LW

[4] For the purpose of the 2009 LW LOE, the LW–Manchu system was used as a surrogate to the NW system. The NW system was not developed at the time of this experiment.

system. The LOE called for each mission to be executed three times while equipped with each alternative BOIP. The LW–Manchu LOE informed three of the five study issues:

- Study Issue 1: How does each alternative contribute to force effectiveness (FE)?
- Study Issue 2: What is the preferred distribution (BOIP) of NW in an IBCT?
- Study Issue 5: Validate the operational KPP and Key System Attributes (KSAs) threshold values.[5]

As the MBL mentioned, one limitation of the study was the LOE's lack of a robust communications network. In order to mitigate the effects of this lack of a reliable network during the experiment, four Stryker infantry carrier vehicles (ICVs) were integrated with LW–Manchu and their EPLRS radios. These vehicles served to increase the range and reliability of the EPLRS network. Although these vehicles are not organic to a typical IBCT, they were incorporated into the evaluation for the sake of establishing a more robust network (MBL, 2009).

1. Summary of Findings

While reducing survivability, the 2009 LW–Manchu LOE revealed that NW capability increased a unit's force effectiveness in two of the three areas: mission success rating and lethality. The EXFOR operated more dispersed and effectively synchronized its movement prior to making contact. The MBL concluded that these factors set the conditions for successful actions on contact. We find it interesting to note that the SL BOIP yielded higher ratings than the TL BOIP. Conversely, the TL BOIP displayed the lowest survivability rating, as shown in Table 1.

Table 1. Basis of Issue Plan Performance Across the Elements of Force Effectiveness (MBL, 2009)

Contribution to Elements FE by GSE BOIP Level			
Element of FE	BOIP		
	Base Case	SL BOIP	TL BOIP
Mission Success Rating	45.4	59.6	47.4
Lethality Rating	35.66	44.29	39.11
Survivability Rating	87.32	85.72	81.71

[5] KPP and KSA define the desired operational capability in a threshold and objective format.

Furthermore, the NW capability alleviated some of the leadership burden and provided leaders with the information they needed to issue successful orders:

> The most noticeable contribution to C2 was related to leaders issuing successful directives. When equipped with LW at their level, SLs issued directives with a 98% success rate and TLs with a 100% success rate. Leaders stated that shared SA between TLs and SLs provided by the LW reduced ambiguity of directives. (MBL, 2009, p. 4)

The MBL also recorded the frequency with which soldiers used the LW–Manchu system's HMD during the missions. Most notably, users reported the highest frequency of HMD usage during navigation and movement to assault position. Upon contact, the soldiers reported less usage of the HMD. This trend was observed during other assessments as well. Figure 16 presents reported HMD-usage findings from the LOE.

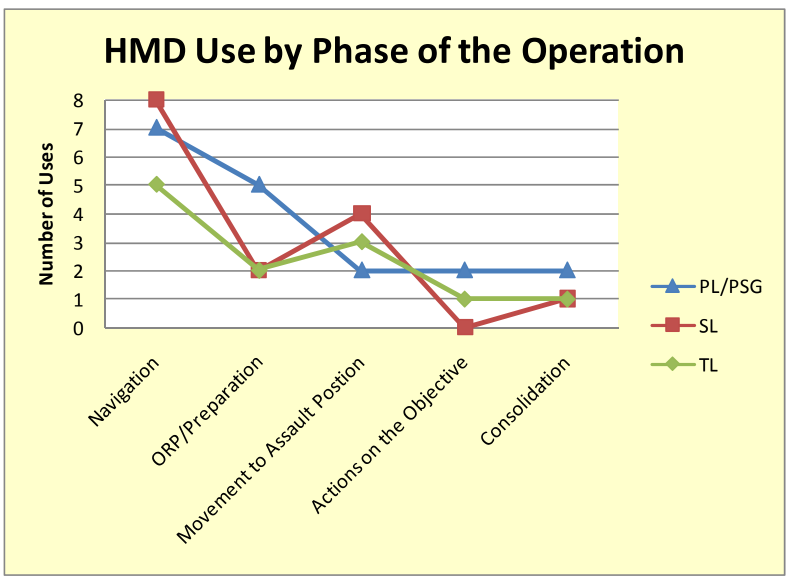

Figure 16. Experimental Force Leader Average Helmet-Mounted Display Use by Phase of the Operation
(MBL, 2009)

The second study question addressed during the 2009 LW–Manchu LOE was the preferred BOIP. Analysis of the data revealed that both LW-equipped platoons had higher force effectiveness ratings than the non–LW-equipped platoons. However, the SL BOIP achieved the highest force effectiveness ratings in four of the five missions. Figure 17 presents the results of the force effectiveness analysis.

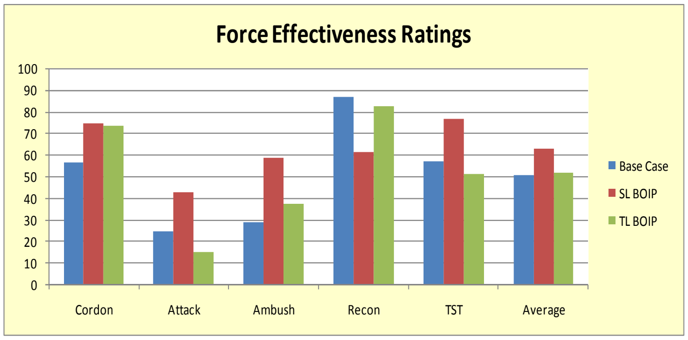

Figure 17. Land Warrior Limited Objective Experiment Force Effectiveness Ratings, 2009
(MBL, 2009)

The MBL identified some of the reasons for the SL BOIP's success:

> The EXFOR set the conditions for a successful operation more effectively with the SL BOIP because they used the NW to enhance baseline capabilities rather than replace them. For example, during movement SLs would provide their lead TL with a distance and direction to the next checkpoint. The TL would then navigate using a baseline capability (Defense Advanced GPS Receiver (DAGR), compass, pace count, etc.). (MBL, 2009, p. 4)

The soldiers conducting the LOE had varied opinions of the BOIP. TLs rated the TL BOIP highest, reporting that shared SA with their SLs enabled them to execute their directives more effectively and, subsequently, to direct their subordinates more effectively. On the other hand, SLs rated the base case highest because they felt system-related problems during the LOE distracted them from executing their mission. The platoon leader and platoon sergeant ratings were similar to the force effectiveness ratings; they rated the SL BOIP highest (MBL, 2009, p. 4).

The final study question for the LW–Manchu LOE validated the operational KPP and KSA threshold values. The performance data from the LOE would be applied to the CDD side excursions as they applied to the following[6]:

- KPP 2 (Battle Command)
- KPP 3 (COP: Shared Friendly SA)
- KSA 4 (Geospatial Data Exchange)

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[6] The LOE did not intend to address all of the program KPPs. It could not address the network (KPP 1) because it required an EPLRS package that is not organic to IBCTs.

- KSA 5 (Mobility)
- KSA 6 (Transmission Range)[7]

TRAC–WSMR needed the data from the LW–Manchu LOE in order to complete the KPP/KSA validation portion of the AoA and to update its simulation exercise (SIMEX) models. Although the MBL did not perform an analysis on the data collected, some of the findings were noteworthy—in particular, the results of the mobility evaluation. In this evaluation, the soldiers negotiated an urban individual movement task (IMT) course while wearing all of their personal protective equipment integrated with LW–Manchu components. Although the system was below the threshold weight value, it was interesting to see the effect the added weight of the LW–Manchu system had on the soldiers. Soldiers wearing the LW–Manchu system were, on average, eight seconds slower negotiating the urban IMT course than soldiers without the equipment. Soldiers without the LW–Manchu system completed the course in an average of 40.45 seconds, while soldiers wearing the system completed the course in an average of 48.55 seconds (MBL, 2009). Soldiers wearing the system believed the additional weight decreased their ability to perform the IMT course. During the assessment, a survey of 30 soldiers reported the system did not give them an advantage while conducting their mission tasks on the IMT course. In fact, four soldiers reported that they felt no difference with or without the system (MBL, 2009).

During the experiment, the EXFOR survivability was rated highest during base case BOIP operations. However, the MBL recorded little difference in the average ratings between the BOIPs. For example, when comparing the survivability rating, there was only a slight decline between the base case and the TL BOIP missions, 87.32 versus 81.71, respectively. Although no direct correlations were reported, the TL BOIP demonstrated the lowest performance ratings in all three effectiveness categories (MBL, 2009).

To summarize the findings of the LW–Manchu LOE of 2009, the MBL reported that the SL BOIP demonstrated the highest ratings for force effectiveness. They found TLs benefitted from the enhanced SA and clarity in receiving directives; however, the TL

[7] The LOE tested transmission range separately, unassisted by the EPLRS radio in the Stryker vehicle.

BOIP showed only marginal improvement in force effectiveness as compared to the base case. The soldiers executing the LOE missions were inconsistent in their choice of a preferred BOIP. Soldiers cited low imagery resolution and perceived position location information (PLI) inaccuracy as factors that reduced their confidence in the system. Consequently, the MBL concluded that these factors affected the soldier's reliance on the system. In the end, the MBL concluded that the SL BOIP led to the highest ratings of force effectiveness because leaders could augment the NW capabilities, as required, with current equipment. Ultimately, the MBL's 2009 LW–Manchu LOE validated that the NW-equipped soldiers were markedly better in terms of force effectiveness than currently equipped soldiers. However, the findings regarding BOIP remained unclear (MBL, 2009).

I. ARMY TEST AND EVALUATION COMMAND LAND WARRIOR–STRIKE EMERGING RESULTS BRIEF, FEBRUARY 2, 2010

From January 6 to 8, 2010, the Army Test and Evaluation Command (ATEC)[8] conducted an emerging results evaluation of the LW–Strike system in Afghanistan. The purpose of this evaluation was to provide the Army G-3 feedback from the 5/2 SBCT on its use of the LW–Strike system during OEF. ATEC conducted a brief survey over the course of three days, surveying only a small sample of the soldiers from the 5/2 SBCT. The survey results highlighted the enhanced capabilities of the LW–Strike system, identified some shortcomings, and provided several recommendations (W. Hiatt, personal communication, October 22, 2011). A summary of ATEC's findings concerning the 5/2 SBCT's employment of the LW–Strike system in OEF focused on the following five areas:

- improved blue SA,
- more efficient navigation,
- soldier mobility impacts,
- lack of sufficient training, and
- critical system limitations.

[8] The ATEC Emerging Results Brief was provided to us through electronic communication from Major Wayne Hiatt, Assistant TCM–Soldier, 2011.

ATEC found that the LW–Strike system provided leaders at all levels with SA of dismounted elements; senior leaders were able to make better informed decisions based on blue SA. A battalion commander stated that he used the system as an additional means of clearing and verifying fires. In an interview with that same battalion commander, he stated,

> We had a very tired and worn out commander on the ground calling for fire and his grids just didn't match up. … I denied him his indirect fire until he was able to recognize the situation he was in and come back with a better call for fire. (W. Hiatt, personal communication, October 22, 2011)

In this incident, the LW–Strike provided a redundant means of verifying friendly unit locations in order to clear fires while mitigating the possibility of fratricide. Close Air Support (CAS) also benefitted from the LW–Strike system because aircraft could quickly identify dismounted unit locations and dispositions via the SADL-to-EPLRS link (W. Hiatt, personal communication, October 22, 2011).

Interestingly, certain models of Air Force aircraft can identify LW icons based on their link with the Enhanced Position Location Reporting System (EPLRS) network on their tactical display via the Situational Awareness Data Link (SADL). Establishing this link from air to ground made a huge impact on coordination. Figure 18 is an example of how SADL enables Air Force aircraft to identify EPLRS-equipped vehicles and dismounted LW–Strike–equipped personnel in OEF (TCM–S, 2010).

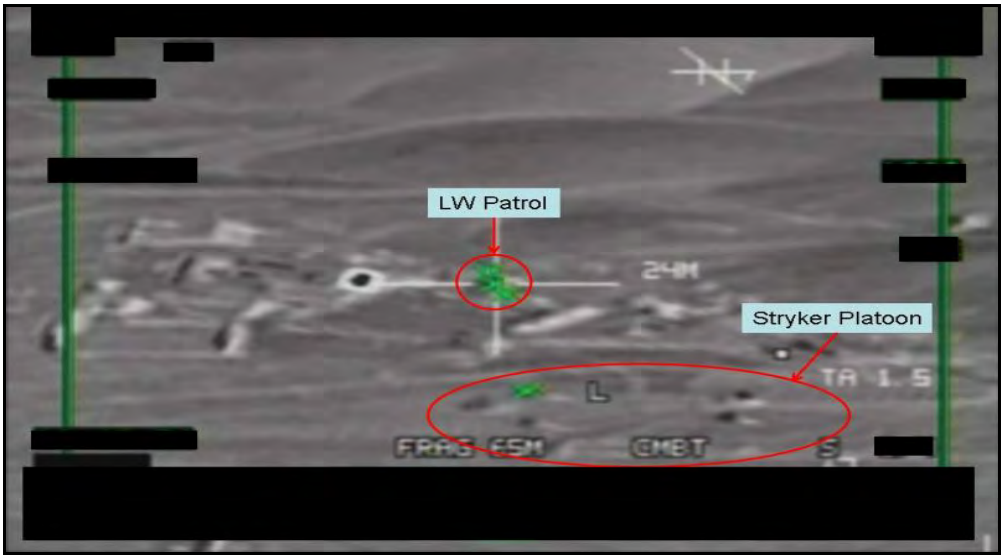

Figure 18. Situational Awareness Data Link
(TCM–S, 2010, p. 6-5)

In addition to the enhanced SA, ATEC found that the 5/2 SBCT soldiers consistently reported that the LW–Strike system increased a unit's ability to maneuver. These findings were consistent with the 5/2 SBCT's NTC rotation in July 2009. During the 5/2 SBCT's OEF deployment, 52% (27 of 52) of the soldiers indicated that LW–Strike was their primary means of navigation. ATEC's findings were compared to the MBL's survey, which yielded 70% (90 of 127) of the 5/2 SBCT soldiers indicating that LW–Strike helped their ability to navigate. Although the soldiers employed the Strike system for enhanced navigation, the added capability came at the expense of added weight and bulk (W. Hiatt, personal communication, October 22, 2011).

ATEC provides their quantitative analysis of the surveyed sample, stating that six of 18 leaders surveyed (two at the platoon [PLT] level, two at the company [CO] level, and two at the battalion [BN] level) stated that the weight/bulk of the system detracts from its value added. Furthermore, ATEC found during two other 5/2 SBCT surveys that 15 of 18 (83%) and 35 of 52 (67%) of the respondents listed weight/bulk as a weakness of the LW–Strike system. The survey also revealed that 31% of the soldiers stated that Stryker ingress/egress was an issue due to the size and bulk of the LW–Strike system. Finally, soldiers in the 5/2 SBCT reported carrying seven different types of batteries to include those required by the LW–Strike system (W. Hiatt, personal communication,

October 22, 2011). The additional batteries required to power all the mission-essential equipment contributed to the overall soldier load and hampered soldier mobility.

As overall soldier mobility was impacted, ATEC found that almost half (41%) of the surveyed soldiers stated that the training duration should have been increased. Two-thirds of the surveyed populations from this question were SLs and TLs. Contrary to these results, 11 of 18 leaders (61%), from platoon sergeant through battalion commander, felt that the training their soldiers received was adequate (W. Hiatt, personal communication, October 22, 2011).

In addition to requesting additional training opportunities, the units ATEC surveyed also indicated that the LW–Strike system had some critical limitations. The first limitation was that the LW–Strike battery life did not support their mission sets in Afghanistan. The typical mission set described by the sampled population included long duration missions, composed largely of dismounted patrols. Each LI-145 battery weighs 2.1 pounds and typically lasts eight hours (W. Hiatt, personal communication, October 22, 2011).

The additional weight of LW batteries came at the expense of carrying other critical items, such as food, water, and ammunition. Although ATEC did not determine the average life of a LW battery, the impact of this limitation centers more on the overall weight of the equipment carried by a soldier, rather than on the inadequate power provided by LW batteries.

Soldiers also reported that the EPLRS network was another critical system limitation of the LW system. The LW–Strike system is an EPLRS-based system, mesh network that uses line of sight to "talk" to other systems. Due to current network limitations and the varied terrain, soldiers reported concerns about the system's limited range and its inability to maintain connectivity. "Once units are out of line-of-site from the Stryker, the SA/Comms is degraded and therefore results in a potential loss of the most valued capability (Blue SA)" (W. Hiatt, personal communication, October 22, 2011). Although the Stryker vehicles increased the robustness of the EPLRS network, dismounted LW–Strike systems produced their own EPLRS network, or clouds, as the soldiers maneuvered away from the vehicles. Their internal clouds weakened as

mountainous terrain and distance separated soldiers from their Strykers and each other (W. Hiatt, personal communication, October 22, 2011).

The next critical limitation ATEC reported concerns voice communications, which may be associated with the lack of a robust EPLRS network. Based on the limited ability of units to communicate with each other, they developed tactics, techniques, and procedures (TTP) in order to use their AN/PRC-148 Multiband Inter/Intra-Team Radio (MBITR) as their primary means to communicate when they were away from the Stryker (W. Hiatt, personal communication, October 22, 2011). This was interesting to note because all LW–Strike-equipped soldiers continued to employ both radio systems, the CNRS and the MBITR. Additionally, the Peltor headsets were regarded as uncomfortable and reduced the wearer's SA. As mentioned earlier, this is another recurring theme in the evaluation of the LW–Strike. As a result of their diminishing employment of the Peltor headsets, soldiers were less inclined to use the cognitive radio network (CNRS) for voice communications. Although the PM continued to seek alternate headsets, the critical limitations of the LW–Strike system were reported as the Peltor headsets and CNRS (W. Hiatt, personal communication, October 22, 2011).

The final critical limitation identified in ATEC's 2010 report centered on the reliability of the LW–Strike system. During combat missions, 79% of the soldiers surveyed said they had an LW–Strike system malfunction (W. Hiatt, personal communication, October 22, 2011). Although this may appear to be high percentage of reported malfunctions, this analysis does not take into consideration the density of errors reported. That is to say, when ATEC conducted this survey in January 2010, the 5/2 SBCT had been deployed to Afghanistan for six months. During those six months, the frequency of errors experienced during combat operations would have been a better determination of the reliability of the system. ATEC further investigated the severity of the malfunctions experienced by the soldiers. Of the 79% who reported a malfunction, 21% of those soldiers were able to correct the malfunction. These findings are consistent with those of the MBL, which found that 20% of the soldiers were able to regain full or partial functionality of their system after experiencing a malfunction. Depending on the severity of the malfunction, most soldiers simply had to reboot the LW–Strike system in

order to gain partial or full functionality. ATEC also pointed out that 31 of 43 soldiers were unable to correct the malfunctions while on mission. No evidence suggested that a mission failed because of a malfunction; the most common impact reported was slowed movement (W. Hiatt, personal communication, October 22, 2011).

Although ATEC's 2010 LW–Strike brief consisted of only three days of surveys, the survey findings reinforced what had already been observed by other organizations. Although soldiers benefitted from the enhanced SA and precise navigation, units continued to report a desire for additional training opportunities prior to deployment. When soldiers received inadequate training on equipment, they always reverted back to the systems they were familiar with and had a higher level of confidence in. The reported limitations of the LW–Strike system's battery life, network range, communications, and reliability are consistent with previous evaluations.

J. TCM–S' REQUIRMENTS DILEMMA

All user representatives face the same challenge of determining the capability requirements to fill gaps or exploit opportunities, while at the same time achieving user buy-in. Each user within that community has a different perspective of what the objective and threshold criteria should be. The dilemma is defining the criteria that best fill the capability gaps while balancing the user community buy-in and what is technologically achievable. TCM–S encountered these challenges when developing the functional requirements for the LW and the NW.

When examining the assessment in this chapter, we noted a disparity in the outcomes. In particular, we identified conflicting assessments surrounding the survivability of the LW. In both ITA's conducted by TCM–S, the 14th small unit capability gap, move under direct fire, was assessed as "not filled" by the LW. TCM–S determined the weight of the LW-Manchu and LW-Strike was negated by the system's capability to coordinate tactical fires and movement techniques. Below is the rationale TCM–S (2008) provided from the 4–9 IN ITA DOTMLPF assessment:

> The [4–9 IN] ITA modified the [2007] TWA [TRAC–WSMR Assessment] from "degraded" to "not filled." The LW [Manchu] system assists in coordinating tactical fire and movement techniques. Land

> Warrior supports actions leading up to the final assault. There is no weight reduction to the current RFI equipped Soldier. Improvements to the system have reduced the weight of the LW system down to 9.94 pounds. Any addition to the Soldier's load may adversely affect Soldiers during extended operations and the strenuous actions associated with individual movement techniques. (p. 6-6)

The TCM–S 2008 and 2010 in-theater assessments are the exceptions when reporting on the impacts to mobility of the LW system; in comparison to reports from external DoD agencies dated 2007, 2009, and 2010,[9] the weight of the LW–Manchu and LW–Strike degraded the soldier's mobility. TCM–S took into consideration the results of these three other assessments when developing the mobility requirements for the NW. However, the technology did not exist to reduce the weight of the system to reflect the user community's feedback. Therefore, TCM–S defined the NW's threshold weight requirement based on the specifications defined by industry. By doing so, TCM–S avoided developing an unachievable weight requirement defined by the user community.

K. NETT WARRIOR

The LW systems served as the prototypes for the NW system. TRADOC initially developed the requirements for the NW in 2006, which were very similar to the LW–Manchu system. The requirements continue to call for a wearable computer that links soldiers into a network with voice, data, and GPS, while operating hands-free. TCM–S expects NW to improve upon the successes of previous LW systems and evolve a lighter system that provides battle command and enhanced SA for dismounted and mounted forces. According to a GAO (2011) report(Extract 11-233SP), the NW has three increments. The first increment concentrated on developing the SA used with the SBCTs (GAO, 2011). In addition, the Army has identified five critical technologies nearing maturity for NW Increment I:

- energy/power management subsystem,
- antenna,

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[9] The external DoD agency assessments discussed here are the 2007 TRAC–WSMR LW/MW DOTMLPF assessment; 2009 MBL LOE; and 2010 ATEC 5/2 SBCT Emerging Results Brief.

- navigation,
- user control, and
- voice intelligibility.

The Army is aware that the NW Increment I will not achieve its fully networked capability until the Joint Tactical Radio System (JTRS) is incorporated after full-rate production (GAO, 2011). In the following chapter, we discuss only the first two increments of the NW system because Increment III is a future development beyond the scope of this report.

K. CONCLUSIONS

When units began taking the LW systems to combat, it allowed the PM to continue to improve the system through feedback from experience in combat. The 4–9 IN decision to take the LW–Manchu system to combat served as the mechanism for change. This facilitated system improvements that would later become the LW–Strike. Three SBCTs would take the LW–Strike system to Afghanistan. Although unplanned, the PM was able to test the system in two vastly different operational environments in Iraq and Afghanistan. However, the LW system served as only a partial solution to the user requirements as developed by TCM–S.

Technology was still not mature enough to fully develop the system that would meet the user expectations. For example, through operational deployments, system reliability was an issue as users reported frequent system reboots. Without a robust network, range of communications led to fragmented networks. User feedback continued to reinforce the need for lighter components to address mobility and survivability concerns.

User buy-in is key to the success of any DoD program. By coincidence, the 4–9 IN had a year to train on individual and collective tasks integrating the LW system prior to deployment. This was never duplicated by follow-on units prior to taking the system to combat. As a result, the system never reached the level of user acceptance achieved by the 4–9 IN. This was not the fault of the TCM–S, who was not in the position to influence

unit training schedules or the availability of LW systems needed to effectively train units prior to deployment.

TCM–S must carefully analyze a litany of metrics concerning supportability, maintainability, reliability, feasibility, cost, schedule, and performance. This careful and thorough analysis must be conducted when determining the correct materiel solution to equip the warfighter. User requirements are also developed through user interaction and feedback. If TCM–S does not receive user buy-in, it affects its credibility and its programs suffer. This requires TCM–S to maintain a balance between industry and the user community to achieve requirements that are both technologically feasible and meet user expectations. All this is done while maintaining a partnership with the PM who is responsible for executing the program requirements. We discuss more on this point in the next chapter. In Figure 19 we break out the LW/NW key events beginning in 2005 through 2011.

	2005	2006	2007	2008	2009	2010	2011
Program Manager Key Dates	EPLRS fills JTRS capability gap HMD & Power mature	First spiral LW equips 4-9 IN (372) DBCS Mature technologies to LW program	Sole Source Fixed Fee awarded to GDC4S for R&D contract of LW LW Cancelled (173 systems not produced)	Senate Arms Committee support LW with $80 million	5/2 SBCT NET	2 SCR NET	1/25 SBCT NET NW base procurement
Contracting Activity	GD builds 500 LWs $30M		Sole Source Fixed Fee awarded to GDC4S for R&D contract of LW Firm-Fixed-Price awarded to GDC4S to produce HMD and LW ensembles (835) GDC4S updates LW	LW-Strike build		Long Lead items for NW procured ($18M)	Three NW CPFF contracts awarded
TCM-Soldier Key Dates				4-9 ITA		5/2 ITA	
Test Activity	DBCS evaluated and found unfit TRAC-WSMR identified capability gaps		TRAC-WSMR Assessment				
Unit Activity		First spiral LW equips 4-9 IN 4-9 IN demo materiel solution as viable	4-9 IN ONS validated, deploys to OIF 4-9 IN continues to refine the LW system; GDC4S makes changes to system in theater	5/2 SBCT ONS was validated	5/2 SBCT NET 5/2 SBCT deploys to OEF (895) TPE 2 SCR ONS was validated	1/25 SBCT ONS validated 2 SCR deploys to OEF (LW TPE)	1/25 SBCT deploys to OEF (LW TPE)
Fund Activity	$72.9M- R&D ($30.8 M OPA dollars)	RDT&E- $49.5M $24.9M DE $10.9M Training $13.6M Support Initial spares $35.2M (OPA) Total $134.1 million	LW was programed for a total of $207.5 million for a total of 1,954 systems through FY11 -- SASC earmarked $80M to support ONS	Earmarked $80M increased to $93.9M -- Funded by OCO OPA dollars	$49.9M obligated; OPA budget $19.9M and HQDA $30.06M (reprogrammed dollars) -- $700,000 OCO: LW-Manchu disposal -- $1.6 B NW Inc I Funds obligated R&D equaled $179.8M $1.48B procurement	No base funds programmed for LW Total NW Funds $40.2M; $9.6 million funds 5/2 SBCT deployment; $21.4M funds 2SCR NET and deployment; $9.2M NET for 1/25 SBCT	$21.8 million (OCO) in support of ONS for LW $110.5M- NW- Base procurement

Figure 19. Key Events in the Land Warrior/Nett Warrior Timeline

IV. THE NETT WARRIOR MATERIEL DEVELOPER'S PERSPECTIVES

A. INTRODUCTION

In this chapter we provide an overview of the NW acquisition strategy and the developmental challenges from the materiel developer's perspective. We will initially discuss the incremental approach of the FFW that led to the development of the NW system. Next, we discuss how the PM abbreviated the typical acquisition model in the development of the NW system. Then, we present the results of the ATEC evaluation of the NW LUT. Finally, we examine how the Army's Configuration Steering Board (CSB) affected the NW program. Ultimately, in this chapter we outline some of the challenges of the development, testing, and production of the NW program.

As General Peter Chiarelli (2011), Vice Chief of Staff of the Army, outlined in his March 9, 2011, address to the U.S. House of Representatives Armed Services Committee, NW was one of the Army's FY2012 priority programs, which was mentioned under the JTRS.[10] NW was on a parallel developmental path of being interoperable with the JTRS RR, AN/PRC-154.

> The Rifleman Radio is the dismounted Soldier capability that utilizes the SRW [Soldier Radio] waveform to connect the Soldier to the Leader. The system provides voice and individual location information [and] primarily serves the maneuver team formation, and provides a complimentary capability to the NW-enabled Leader. (Chiarelli, 2011, pp. 9–10)

While on parallel developmental paths, the ultimate goal was to provide the ground fighting soldier with enhanced SA and communications capabilities leading toward a net-centric effect of combining interoperability of voice and data systems.

B. INCREMENTAL APPROACH TO THE FUTURE FORCE WARRIOR

In 1989, Natick Soldier Center introduced the soldier system concept, commonly referred to as SaaS. This approach considered viewing the soldier as a functioning system

[10] The JTRS is a DoD–wide initiative to develop a family of revolutionary software-programmable tactical radios interoperable across the joint battle space providing the warfighter with voice, data, and video communications.

similar to that of any other major weapon systems, such as a tank or helicopter. Viewing soldiers as a system led to the development of the current NW system and the FFW program. According to Philip Brandler (2005), U.S. Natick Soldier Center, there were four increments planned for the FFW, which encompassed the DBCS, LW, and NW Increment I and II (Brandler, 2005). Figure 20 depicts the four increments of the FFW. We created this figure using images from TCM–S (2008) and Smith (2009).

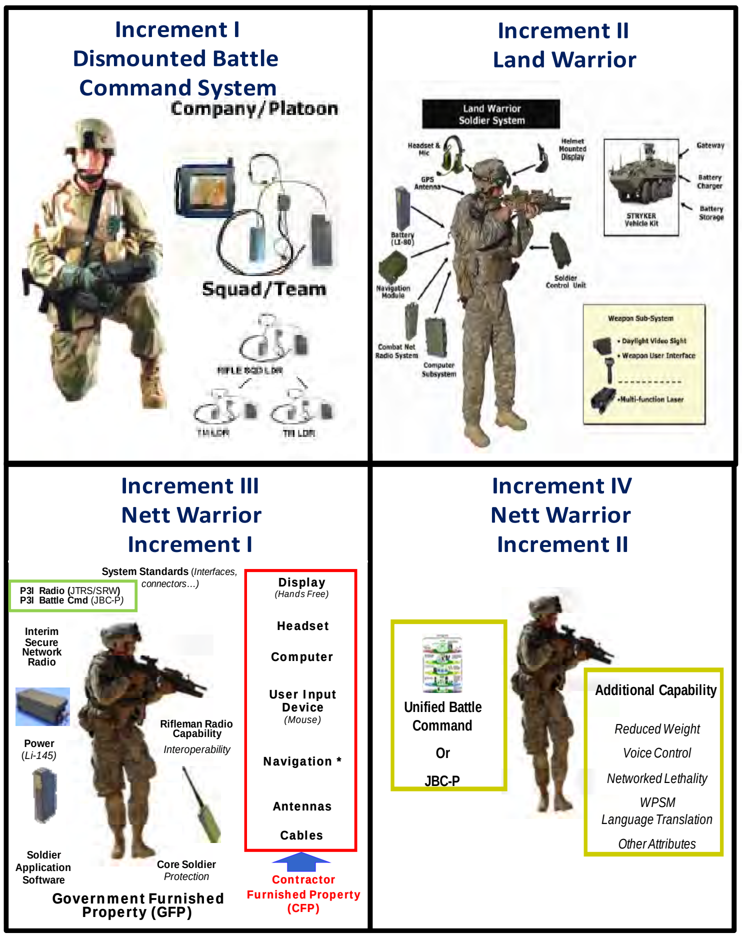

Figure 20. Incremental Approach of the Future Force Warrior
(TCM–S, 2008; Smith, 2009)

The first increment of the FFW consisted of the DBCS, which included a hand-held Commander's Digital Assistant (CDA) and EPLRS or MicroLight radio to assist soldiers in navigation, mission planning, and blue force tracking capabilities (Brandler, 2005).

The second increment was the LW system. This increment focused on enhancing the SA of dismounted soldiers within the SBCTs. The LW system expanded the soldier's SA via connectivity with the lower tactical internet, vehicle to dismounted soldier communications and soldier to soldier communication while mounted and dismounted (Brandler, 2005). Lessons learned from combat deployments to Iraq and Afghanistan were applied to the development of the next increment of the FFW, the NW system.

The third increment of the FFW is the NW system, which began in 2009. This increment is also known as NW Increment I (NW Inc I). NW Inc I will be a fully integrated modular system that meets the threshold requirements of the NW CDD with improved capabilities in lethality and survivability while being interoperable with various vehicle platforms. NW Inc I will integrate multiple soldier systems and components while leveraging emerging technologies (Brandler, 2005).

NW focuses on the development of SA systems, enhanced navigation, and reduction of fratricide facilitated by a shared COP on a digitized battlefield. This program includes pre-planned product improvement (P3I) to integrate the JTRS small form factor B (SFF–B) once the system is validated and proven (Smith, 2009).

The fourth increment, NW Increment II, is the objective system, which builds upon the previous increment's CDD threshold system. This system is intended to fully integrate the dismounted soldier under a unified battle command system and additional emerging technologies with the network (Brandler, 2005).

C. NETT WARRIOR SYSTEM ACQUISITION STRATGEY

Unconventional with respect to most acquisition programs, the NW's strategy planned to abbreviate the systematic progression of achieving Milestones A, B, and C. The NW program bypassed Milestone B, planning to progress from Milestone A to Milestone C in approximately 21 months, 7.5 months prototyping phase and 13.5 month refinement phase, as shown in Figure 21 (Cummings, 2009).

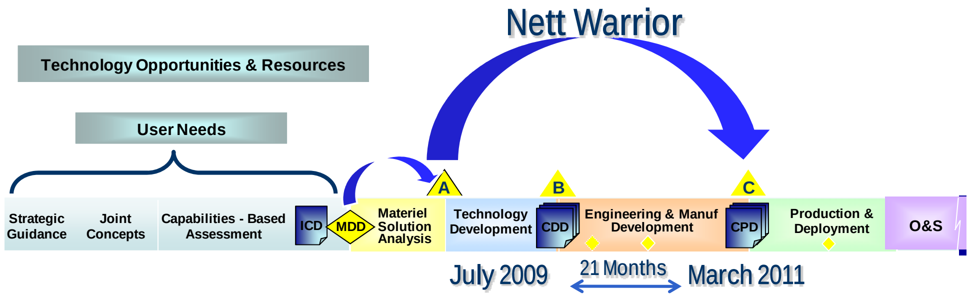

Figure 21. Nett Warrior's Abbreviated Acquisition Roadmap
(Under Secretary of Defense for Acquisition, Technology, and Logistics [USD(AT&L)], 2008)

The NW acquisition strategy incorporated mature technology from the LW's radio, communication software, and battery. In June 2009, the PM for NW commented about the developmental strategy,

> We are driving the industry partners to focus in on reductions in weight, size and the overall power management of the system. I don't want them to go out there and recreate a new radio or headsets, they are already out there and the government can provide that. What I want them to do is to take the basic guts of the system and put more capability in a smaller box. (Cummings, 2009)

The overall acquisition strategy was intended to manage the technological risk of the program while reducing the overall schedule. In the program's February 19, 2009, Milestone A acquisition decision memorandum (ADM), in addition to providing exit criteria, it also allowed for a Milestone B or C decision review based on the technology readiness levels.

The deputy PM for LW stated that the NW program planned to demonstrate the technology readiness in order to bypass Milestone B:

> The DAB [Defense Acquisition Board] will review the program at the conclusion of the Limited User Test (LUT) to assess readiness for entry into either the Engineering and Manufacturing Development (EMD) phase or the Production & Deployment (P&D) phase. The decision to pursue EMD or P&D (i.e., approve Milestone B or C) will be informed by the results of the LUT and a Technology Readiness Assessment of the GSE program by the Director, Defense Research & Engineering. The decision

to approve Milestone B or C will also be contingent on meeting the requirements of section 2366b of title 10, USC. (Geddes, 2010)[11]

The technology development strategy (TDS) from December 2008 projected the NW Milestone C decision for the end of 2QFY2011 (D. Edwards, personal communication, November 23, 2011). Having gained approval in February 2009 from the Milestone Decision Authority (MDA), John J. Young, Jr., former USD(AT&L), the program was able to bypass Milestone B based on the technology readiness levels of the system (D. Edwards, personal communication, November 23, 2011). After completing the LUT, the NW program intended to conduct a down-select, eliminating at least one of the three vendors prior to achieving a Milestone C decision. After Milestone C, the program would enter into the production phase in order to begin equipping 30 brigade combat teams (BCTs) with the NW system. Figure 22 depicts the initial acquisition roadmap.

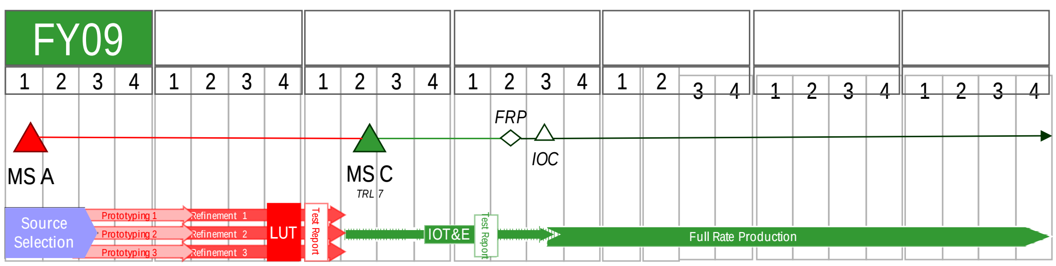

Figure 22. Initial NW Acquisition Roadmap
(Wood, 2009)

D. NETT WARRIOR: MATERIEL SOLUTION ANALYSIS PHASE

In 2008, the NW program began with the materiel solution analysis (MSA) phase, which assessed potential materiel solutions to fill a military need. In this case, the Army continued to pursue a battle command system for the ground fighting soldier. The MSA phase began only after the Joint Requirements Oversight Committee (JROC) approved the Initial Capabilities Document (ICD). The ICD defined the requirement for a materiel or non-materiel solution and summarized the DOTMLPF assessment.

[11] The NW APM provided this February 2009 ADM excerpt on November 30, 2010.

During the pre-Milestone A activities for the NW program, observations from 4–9 IN's employment of the LW system refined the user's needs and capability gaps. In a master's thesis by Nile Clifton, Jr., and Douglas Copeland (2008) completed at the NPS, the authors interviewed PM LW about the use of unit system integrators (USIs) with 4–9 IN. The authors reported that prior to 4–9 IN deployment, the PM implemented the USI concept to address declining user acceptance to the LW system. The primary purpose of the USI was to utilize a certified LW instructor knowledgeable on all technical issues of the system that could assist with training plans and operational procedures. These USIs were embedded with the unit and developed a habitual relationship. During the 4–9 IN deployment, April 2007 to June 2008, USIs, field service representatives (FSRs), and TCM–S were embedded with the unit at the company and battalion level. In addition to assisting the unit with system application, sustainment, training, and maintenance, these personnel also gathered relevant operational feedback from the unit (Clifton & Copeland, 2008).

The operational feedback from 4–9 IN, combined with the 19 small unit capability gaps[12] defined by the LW/MW DOTMLPF assessment conducted from May 2006 to February 2007. The 19 small unit capability gaps identified by the 2007 LW/MW DOTMLPF assessment, depicted in Figure 23, were incorporated into the materiel solution analysis leading to the NW Milestone A decision in 2QFY2009 (TCM–S, 2008). From the gathered operational feedback, the NW's MSA was informed of the current user needs, operational constraints, and functional requirements that contributed to the NW's acquisition roadmap.

[12] The 2007 LW/MW DOTMLPF assessment was intended to inform the 2007 LW Milestone C decision of March 2007 (TCM–S, 2008).

Task	Small Unit Capability Gap	Group
1	Leaders gain and maintain SA/SU*	C2
2	Coordinate movements and fires of subordinate elements	
3	Receive, process, and report tactical information	
4	Receive and issue orders and instructions with overlays	
5	Perform voice communications	
6	Navigate dismounted as a small unit	
7	Coordinate with adjacent units	
8	Fight dismounted ICW armored vehicles	
9	Direct dismount from an armored vehicle	
10	Kill or suppress Enemy with indirect fires	Fire Support
11	Request and adjust fires from a Joint source	
12	Conduct engagements with precision munitions	
13	Conduct personnel and vehicle checkpoints	Close Fight Actions
14	Move under direct fire	
15	Direct employment of smoke	
16	Enter a building during an urban operation	
17	React to man-to-man contact	
18	Locate mines and booby traps	
19	Kill Enemy using direct fire weapons	

Figure 23. The 19 Small Unit Capability Gaps Defined by the 2007 LW/MW DOTMLPF Assessment
(TCM–S, 2008)

E. NETT WARRIOR: TECHNOLOGY DEVELOPMENT PHASE

On February 15, 2009, the NW program entered into the technology development phase and awarded cost-plus-fixed-fee contracts to General Dynamics, Raytheon, and Rockwell Collins for prototypes (GAO, 2011, p. 146). Following the contract award, the PM met with all three awardees to conduct a kick-off meeting on April 20, 2009. During this meeting, the PM addressed all three awardees focusing on his vision of success, laying out program goals and discussing the specifics of the statement of work (SOW). Other topics addressed were detailing a common understanding on communication procedures, schedule, deliverables, and risks to the program (Wood, 2009). Additionally at the meeting, the PM NW directly addressed hoped-for benefits of competitive prototyping, as described in the following quote:

> LTC Roland Gaddy, Program Manager for NW, said all three competitors have a history with soldier systems. General Dynamics was the prime contractor on Land Warrior, but Rockwell Collins built a lot of the hardware and Raytheon provided the radio for the system. Using three competing companies during the development phase of the program likely will mean that the Army will get more bang for its buck come production time. It drives down price and drives up innovation. (Beidel, 2010)

Each of the vendors produced 60 competitive prototype systems that underwent developmental testing led by ATEC at Aberdeen Proving Ground, MD, and Electronic Proving Ground, AZ, from May through August 2010. The developmental testing revealed that each of the three vendors experienced shortcomings in their systems, which were scheduled for the LUT in October through November 2010. "During developmental tests in May–June 2010, none of the contractor-provided NW systems met the threshold for Mean Time Between Essential Function Failure (MTBEFF)" (GAO, 2011). All three of the vendors were to make improvements to their systems in order to achieve the threshold for MTBEFF prior to entering into the LUT. The PM planned to combine the operational testing with the LUT, taking advantage of combining the test events to reduce cost and schedule impacts.

In October 2010, the NW program projected completion of Milestone C in 2QFY2011. However, without an approved presidential budget for FY2011, continuing resolutions constrained funding that could be made available for the NW program. The continuing resolutions limited the amount of funding available because funds were not appropriated. After the FY2011 budget was approved, the Milestone C preparation restarted in May 2011 and was rescheduled for mid-July. The resulting two month schedule shift is reflected in Figure 24 as of May 2011. The chart also shows how the feedback gathered from operational deployments influenced the program's development. We created this figure using images from the ATEC's NW LUT results (W. Hiatt, personal communication, October 22, 2011).

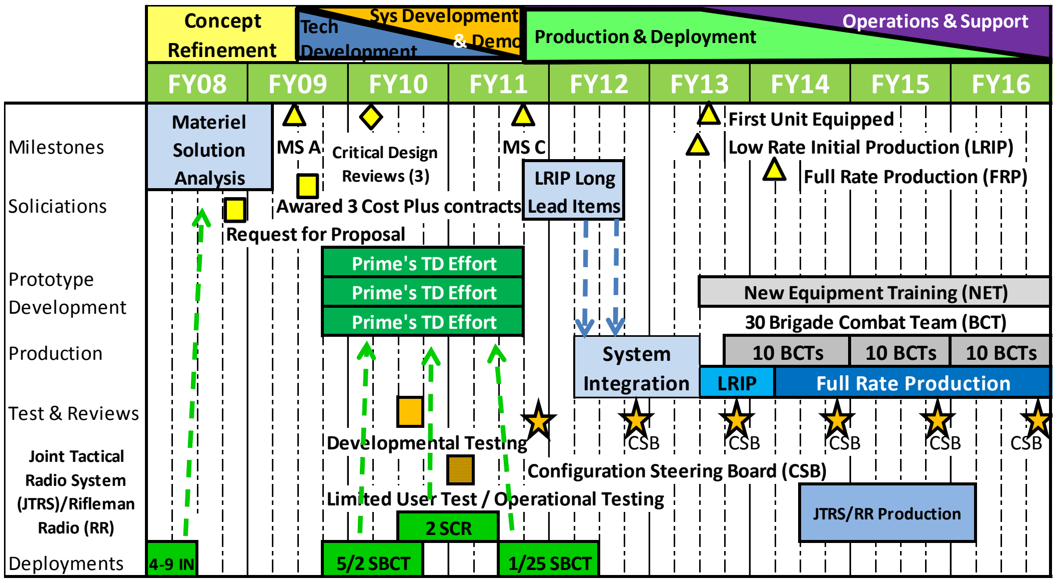

Figure 24. Nett Warrior Acquisition Roadmap as of May 2011[13]
(W. Hiatt, personal communication, October 22, 2011)

The NW system was originally intended to be an improved system spawned from its predecessor, the LW system. The vendors received government-furnished property, giving them a partial materiel solution. Therefore, the vendors began their development and integration efforts with a partial materiel solution. The vendors would develop the remaining components, which included the hands-free display, the headset, the computer, the user input device, the navigation system, the antenna, and the associated cables (Smith, 2009). Although limiting some of the developmental risk by using what was thought to be mature technology, this strategy also reintroduced shortcomings of the LW system associated with the weight, power, radio, and reliability.

Below is a list of the significant milestones achieved and future plans for the NW program as 1QFY2011 from the PEO–S (2011, p. 188).

PROGRAM STATUS

2QFY2009	Milestone A
3QFY2009	Competitive contracts awarded (three)

[13] Figure 24 depicts the operationally deployed units equipped with LW: 4-9 IN, 5/2 SBCT, 2SCR, and 1/25 SBCT.

4QFY2011 [09][14]	Prototyping phase
1QFY2010	Field evaluations (three)
1QFY2010	Critical design reviews (three)
3Q–4QFY2010	Developmental testing
4QFY2010	LUTs (three)

PROJECTED ACTIVITIES[15]

2QFY2012	Contract award/down-select to one or two vendors
3QFY2013– 1QFY2014	Low rate initial production
2QFY2014– 4QF20Y16	Full rate production

F. NETT WARRIOR LIMITED USER TEST (OCTOBER–NOVEMBER 2010)

After completing developmental testing in August 2010, the NW LUT was conducted at Fort Riley, KS, from October to November 2010. This event was the first operational test event for the NW systems (GAO, 2011). Three companies from a battalion were equipped with one of the three vendors' sets of prototypes. The ATEC supervised the LUT, calling for each company to cycle through separate but parallel tests on simulated urban, dense woodland, and open terrain. Each vendor system conducted 96-hour scenarios in the three different terrains (Lundgren, 2010). The companies tested the NW system separately from each other to maintain the competition-sensitive nature of the LUT. None of the testing units saw the other version of the NW they were testing (Gould, 2010). Upon completion of the 2010 NW LUT, PM NW planned to conduct a down-select, eliminating at least one of the three competing vendors (Geddes, 2011).

[14] This is a correction to the calendar on PEO–S's website. Based on the acquisition lifecycle framework, this should be FY2009.

[15] At the time that PEO–S released the projected NW activities, the actions of the Configuration Steering Board were not known.

G. ARMY TEST AND EVALUATION COMMAND’S NET WARRIOR LIMITED USER TEST ASSESSMENT (MAY 2011)[16]

In May 2011, ATEC briefed its assessment of the NW LUT in preparation for the Milestone C decision. Their analysis found that NW improved current capabilities for SA, navigation, planning, and some aspects of command and control (C2). “The capability [NW] shows promise and is highly desired by TCM–Soldier; however, all vendors require additional materiel solution modifications to realize a capability at all echelons” (W. Hiatt, personal communication, October 22, 2011). ATEC recommended that the NW system not be deployed until improved technical performance has been demonstrated principally regarding clarity of voice communications, system reliability, electromagnetic interference/electromagnetic compatibility (EMI/EMC), and weight/bulk (W. Hiatt, personal communication, October 22, 2011). We cover lower level recommendations later in this section.

1. ARMY TEST AND EVALUATION COMMAND’S NETT WARRIOR LIMITED USER TEST EFFECTIVENESS ASSESSMENT

ATEC’s NW effectiveness assessment concluded that poor mobility and voice communications negated the positive effects on mission accomplishment, resulting in an overall negligible outcome. Soldiers felt that their individual mobility was negatively impacted by the additional 14 pounds of weight from the NW system with three batteries (KSA 5).[17] In addition, 82%–90% of the soldiers rated voice communications as ineffective due to a lack of clarity (W. Hiatt, personal communication, October 22, 2011). ATEC also found that NW’s utility was significantly tied to the echelon, specific mission, and phase of operation (W. Hiatt, personal communication, October 22, 2011). Figure 25 depicts how the utility of the NW system varied by echelon.

[16] The NW Milestone Decision Brief was provided by Major Wayne Hiatt, Assistant TCM–Soldier, who received it from Major Doug Copeland, Assistant PM NW.

[17] ATEC instrumentation added an additional 11.1 pounds to the soldier.

	Team Leaders	Squad Leaders	PLT Level	CO Level
SA	***Limited Utility*** chemlights to see adjacent, higher units, contact reports	***Limited Utility*** chemlights to see subordinate, adjacent, higher units, contact reports	***Significant Utility*** see subordinate and adjacent units contacts reports	***Significant Utility*** visualize the battlefield
C2	***Very Limited Utility*** limited texting NW not primary voice	***Limited Utility*** standard messages NW not primary voice	***Utility*** chemlights standard messages NW not primary voice	***Utility*** standard messages chemlights NW not primary voice
Planning	***Very Limited Utility*** follow planned routes	***Utility*** understand higher plan have graphics	***Significant Utility*** have and pass higher plan have and pass graphics	***Significant Utility*** have and pass higher plan have and pass graphics
Navigation	***Significant Utility*** land nav 10 digit grid	***Significant Utility*** land nav terrain analysis	***Significant Utility*** routes planning terrain analysis	***Significant Utility*** terrain analysis routes planning
Mobility	***Negative Impact on Utility*** Degrades IMT & Soldier mobility	***Negative Impact on Utility*** Degrades IMT & Soldier mobility	***Limited Impact on Utility*** Degrades IMT & Soldier mobility	***Limited Impact on Utility*** Degrades IMT & Soldier mobility

Figure 25. ATEC's 2011 NW LUT Assessment: Utility Assessment by Echelon
(W. Hiatt, personal communication, October 22, 2011)

2. ARMY TEST AND EVALUATION COMMAND'S NETT WARRIOR LIMITED USER TEST SUITABILITY ASSESSMENT

The overall operational suitability of the NW was evaluated as "not suitable," according to ATEC's NW LUT assessment. Soldiers reported that the NW degraded operations in terms of its reliability, maintainability, weight, and human factors engineering (HFE). Reliability was low due to the frequent system reboots,[18] which significantly reduced system utility. Maintainability was degraded due to the immature built-in test (BIT) that could not correctly diagnose faulty line-replaceable units (LRUs)[19] with 80% accuracy. Furthermore, the NW systems did not meet the 95% requirement that all malfunctions were to be correctable at the field level within 20 minutes for dedicated maintenance support and for operators (W. Hiatt, personal communication, October 22, 2011).

[18] The LW–Manchu demonstrated system failures that also resulted in reboots.

[19] A line-replaceable unit is a modular component of a system that is designed to be replaced quickly at an operating location.

3. ARMY TEST AND EVALUATION COMMAND'S NETT WARRIOR LIMITED USER TEST SURVIVABILITY

ATEC found that the majority of survivability requirements were either not met or not assessed and, overall, were degraded operations. The three major categories that affected the survivability of the NW system were EMI/EMC; susceptibility to light emissions; and chemical, biological, radiological, and nuclear (CBRN) standards (W. Hiatt, personal communication, October 22, 2011).

4. ANALYSIS OF ARMY TEST AND EVALUATION COMMAND'S NETT WARRIOR LIMITED USER TEST ASSESSMENT

To summarize the ATEC's overall assessment of the NW LUT, all three versions of the competitive prototypes demonstrated significant deficiencies. ATEC recommended that the NW system not be deployed until improved technical performance was achieved. The system deficiencies identified by ATEC's evaluation may have contributed to the involvement of the Army's CSB to curtail the possible growth in development and procurement costs of the NW's approved baseline cost estimate.

H. NETT WARRIOR AND THE CONFIGURATION STEERING BOARD

At the July 11, 2011, pre-Milestone C Army System Acquisition Review Council (ASARC), the PM NW suggested incorporating a smart phone device. The Vice Chief of Staff of the Army (VCSA) supported his suggestion, leading to the discussion on how this could be accomplished. "The ASARC agreed that the smart phone device was the best COA [course of action] and, as a consequence of approving the recommended path ahead, the PM had to go to the Configuration Steering Board (CSB) for de-scoping" (Geddes, 2011). In following month in August 2011, the CSB de-scoped the NW requirements, allowing the smart phone device to be incorporated into the NW system (W. Hiatt, personal communication, October 22, 2011).[20] The Army called this smart phone device the end user device (EUD). In addition to the NW LUT assessment, PEO–S identified several other factors that significantly influenced the CBS's adjustment of the NW requirements:

[20] Major Wayne Hiatt, Assistant TCM-S, provided the trigger CSB NW brief.

- emergence of low cost, commercial technologies;
- demonstrations of viable commercial-off-the-shelf (COTS) items, in particular, smart phones; and
- current constrained budgeting influences.

The PM NW conducted a trade-off analysis of how a smart phone device would impact the small unit capability gaps and size, weight, power, and cost (SWAP–C). The rationale for the NW's KPPs and KSAs were adjusted to address SWAP–C concerns and incorporate emerging commercial technology. In effect, no KPPs were changed and only one KSA was changed from 24 hours of power to eight. In addition, KSA 5, mobility, was reduced from a maximum of 14 pounds down to three pounds. Including the 2.2 pounds from the RR, the total weight of the NW EUD system would be approximately 5.7 pounds with eight hours of operation (W. Hiatt, personal communication, October 22, 2011).

The CSB was also informed of the associated limitations of using a commercial-based smart phone device connected to the RR. These limitations included incorporating commercial standards for ruggedization of the smart phones and relying on RR to secure the data transferred between RR systems. The ruggedization of the smart phone will be a consideration for the PM in terms of logistical support to provide spares due to meeting commercial standards for shock, drop, and environmental resistance. An adequate number of spares will need to be available to maintain operational availability (W. Hiatt, personal communication, October 22, 2011).

I. NETT WARRIOR END USER DEVICE

Given the long history of weight, size, and capability issues from the LW system, NW will integrate lighter, relatively inexpensive smart phones to alleviative issues that plagued the previous versions. PEO–S recognized the significant cost and weight savings through researching and testing COTS smart phones. PEO–S estimates that moving forward in this direction will drop 70% of the original weight from the system (Lowe, 2011). The deputy PM for NW also confirmed that connecting an EUD to the RR with secure voice and data capabilities will reduce the original program procurement cost of the NW by 50% (Lowe, 2011). Due to the reduction in total program cost, the NW

program changed acquisition category (ACAT) from ACAT I to ACAT II. With the change in acquisition category, in addition to the program dollar threshold reduction, the oversight fell from DoD-wide to Army level. With the addition of the EUD, NW will focus its efforts on providing position location, enhanced navigation, and enhanced SA through a digital, secure COP. As demonstrated by the ITA and user feedback, these three capabilities have been the most utilized NW functions. Figure 26 shows PEO–S's latest NW EUD with a chest mount and the JTRS radio.

Figure 26. Net Warrior End User Device With JTRS Radio
(PEO–S, 2011)

While incorporating the commercial technology, PM NW is aware of the associated security challenges in the near future. With the commercially available devices of the "open" Android system, the smart phone will be connected to the secure network through the AN/PRC-154 RR. Therefore, PM NW is confident in minimizing the hacking risk (Lowe, 2011). In the spring of 2012, PEO–S is expected to announce which smart phone will be incorporated into the NW system and plans to annually review advances in commercial technology (Lowe, 2011).

In accordance with the PM's suggestion to incorporate an EUD, the PM has mitigated the issues of power and weight that plagued previous NW and LW systems. However, this course of action directly ties the success of the NW program to the RR, or similar radio, that is to be integrated. The NW system no longer is responsible for

providing the devices that generate the network, provide GSP tracking, hearing protection, and a microphone. These requirements are inherent to the communication device with which the NW system will integrate. Alleviated from these requirements, the NW program can shift its focus on the situational awareness and battle command performance aspects that have provided soldiers with the most utility according to operational feedback and assessments.

The NW program expects a two quarter delay to incorporate the EUD. The PM NW plans to meet the Army's acquisition objective of fielding 30 BCTs by the end of FY2017. Considering the significant change in the program's direction, a six-month delay is of marginal impact.

J. NETT WARRIOR END USER DEVICE SUSTAINMENT PLAN

Unlike the sustainment plan from the LW deployments, the NW EUD should enable the Army to completely manage the logistics support required upon fielding. During the LW deployments, the contractor logistics support (CLS) plan consisted of two sub-units established at each FOB: the USIs and the FSRs. Although serving not only to provide sustainment training, the USIs and FSRs provided field-level maintenance support and managed the depot-level maintenance. The CLS package managed all spare components for the LW system (TCM–S, 2010). Due to the relatively low cost of a smart phone and lack of components, the NW EUD should not require as robust of a CLS package as the LW system. By design, the EUD is a low unit cost device with only one major component. Technical support could be made available through a help desk and user tutorials to assist operators to use the full capability of the EUD. The technical support would also assist in restoring operation during malfunctions.

K. LESSONS LEARNED

There are several lessons learned during the development of the NW. There were several important program management considerations noted concerning integration of COTS, risk management, and maintaining flexibility. The PM was able to apply lessons learned from the 4–9 IN deployment during the pre-acquisition phase of the NW acquisition. However, during the acquisition phase, the PM experienced a sliding scale of

user acceptance, beginning with the deployment to Afghanistan. The NW program was directed to reassess its acquisition strategy due to diminishing user acceptance, increased user expectations, and the emergence of the smart phone.

As demonstrated with the NW, incorporating commercial COTS components may justify abbreviating the acquisition model, but this action does not necessarily reduce risk to the program. From 4–9 IN's operational feedback, the system filled or mitigated 13 of the 19 small unit capability gaps. The majority of the Manchu feedback openly praised the LW system. Therefore, the NW acquisition strategy in 2009 incorporated several key components from the LW system. The U.S. Army Contracting Command awarded contracts to three vendors to develop the NW system for testing and evaluation. The PM NW executed testing of the three prototypes at Fort Riley, KS, in order to inform the MDA to achieve Milestone C set for mid-July FY2011. However, as the operational environment changed and the emergence of the smart phone proliferated in the commercial market, soldier acceptance began to waiver, as evidenced by ATEC's emerging results brief of 5/2 SBCT in February 2010 and 2SCR's post deployment surveys of July 2011.

Common to most acquisition programs, defining the materiel requirements can present a challenge and become part of the problem. Leveraging the feedback from 4–9 IN, the NW was on the glide path to fulfilling the KPPs and KSAs. Even though the NW system came in at seven pounds, half of the threshold weight requirement, soldiers still reported that the weight of the system affected their mobility. However, soldiers questioned why they were being fielded a seven-pound system when a smart phone weighed only a fraction of that, approximately three pounds.

There are two considerations commonly overlooked when discussing smart phone technology for the warfighter. First, how can the Army establish a network to support the smart phone? Second, how might the system secure the information transmitted while using commercial technology? Soldiers saw the smart phone provide similar capabilities to that of the NW system, at a fraction of the weight. Soldier feedback became one of the driving forces for the PM to re-examine the NW program strategy.

L. CONCLUSION

From the materiel developers' perspective, several lessons can be learned from the NW program. In particular, generalizations can be made that may apply to other programs within the DoD acquisition community. PMs have long understood that user acceptance is the key for any program to succeed. This tenet has been evident through the LW and was the rationale behind embedding USIs into a unit as early as possible.

From a strategic point of view, active participation and sponsorship in technology demonstrations and initiatives related to an emerging system can have a favorable effect on the future of a program. Push and pull feedback mechanisms must be established amongst PMs, TCMs, and key users. PMs and TCMs must be willing and able to rapidly respond to customer feedback.

NW has written a new chapter in the history of the warfighter's battle command system. The combined effects of the July 2011 ASARC and the August 2011 CSB are yet to be fully understood. Whatever the case may be, the PM must continue to be engaged in maturing technology to deliver required capabilities to the users in a timely and cost-effective manner. Through the CSB's actions, the NW program was able to incorporate an innovative solution, alleviating issues of weight and power.

While exploration of emerging commercial technologies combined with the authorization of the ASARC has resulted in a new direction for the NW program, several ongoing challenges remain. First, the PM must continue to take a holistic approach to integrating the SaaS concept to the NW, while placing the least amount of burden on the warfighter. Additionally, the PM must attempt to minimize the impact placed on the soldier through weight and mass that have plagued the previous version of the NW and its predecessor, the LW. A new challenge is posed by the development of the NW EUD that must succeed through rigorous developmental and operational testing prior to fielding. The optimal solution is one that balances proven capabilities at an acceptable weight in a configuration that achieves user buy-in.

NW has come a long way in resolving some of the difficulties mentioned in this section. The way ahead must be grounded in thorough testing in order to rectify many of

the deficiencies ATEC has identified. The PM must place increased emphasis on improving operational effectiveness, suitability, and sustainability. In addition, improvements regarding reliability, supportability, and affordability should be considered. In sum, the outlook is good, but the future NW system must be thoroughly tested before equipping soldiers.

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V. BUDGET DECISIONS AFFECTING THE LW/NW PROGRAM

A. INTRODUCTION

Do more without more!

– Ashton Carter (USD[AT&L], 2010)

The country is fighting an economic crisis and the Secretary of Defense is looking for ways to cut spending in order to maintain military capacity. Under the current fiscal situation, programs big and small come under close scrutiny. As former Secretary of Defense Gates reminded us in his speech at the Eisenhower Library on May 8, 2010,

> Eisenhower strongly believed that the United States—indeed, any nation—could only be as militarily strong as it was economically dynamic and fiscally sound. We recognize the imperative need for this development. Yet we must not fail to comprehend its grave implications. (Gates, 2010)

This is also echoed in the above quote from former USD(AT&L) Carter.

To reinforce the imminent changes in the acquisition community, Carter provided guidance in September 2010 to all acquisition professionals. In his memorandum he stated his guidance for obtaining greater efficiency and productivity in defense spending. What this means for the Army is an inward look at itself and how dollars can be saved. The NW program will be a target for affordability and control of cost growth.

In this chapter we outlines the budget allocated for the LW/NW soldier system. Through an analysis of the FY budgets and Congressional report language, we discuss the impacts of the program's budget appropriations during FY2006 to FY2011. Although the scope of our research covers FY2006 to FY2011, it is our intent to give the reader background on the decisions that affected FY2006. In order to do so, our analysis begins with a review of program decisions that occurred in FY2005. As we will discuss, the funding for this program is atypical.

B. ACQUISITION STRATEGIES AND CONGRESSIONAL BUDGET DECISIONS

Acquisition strategy is a framework for planning, directing, contracting for, and managing a program. All actions required for a successful program are scheduled within this framework. An acquisition strategy must gain approval prior to execution of Milestone B and requires updates whenever the program goes through a major decision review (Defense Acquisition University [DAU], 2011a).

As a negative example, the failed development of the battle command system in FY2005 shows how schedule shifts and program delays can jeopardize or postpone a program's development. When the PM was directed by the Army to develop the battle command system, the subsequent split in funds and development caused a change to his program strategy that resulted in an 18-month slippage of the LW development (Clifton & Copeland, 2008).

C. LAND WARRIOR/NETT WARRIOR CONGRESSIONAL AND ARMY BUDGET DECISIONS

1. FY2005

a. Acquisition Strategy for FY2005

In 2005 the Army made the decision to focus the LW development into a Stryker battalion for the purposes of a DOTMLPF assessment in FY2006. During this year, two of four critical LW technologies were mature. Amongst the mature items were the HMD and power (battery). The two lagging technologies were the personal area network (the cables, connectors, and interface that link the system to each of its components) and the JTRS radio communications package. The JTRS radio was viewed as the biggest program risk because it was not expected to be mature until FY2011. In light of the radio delay, the EPLRS radio, single channel, COTS system was chosen as a short-term solution until the JTRS became available (GAO, 2005).

During this year, the PM re-focused the LW program strategy to include the battle command system. General Dynamics Defense Systems (GDDS) was awarded a CPFF contract to develop the battle command system capabilities and continued to develop the

LW in parallel efforts. The battle command system is a hand-held device, similar to today's tablets and met most of the LW requirements. It used a different communications package called the EPLRS MicroLight Radio waveform. During operational testing (OT) by the 10th Mountain Division at Fort Drum, NY, the battle command system was found to be unreliable and not ready for fielding. The test results that demonstrated the system was not mature included excessive weight, unreliable communications, and poor user interface. Negative user feedback from the battle command system OT led the PM LW to restructure the LW program (Director, Operational Test & Evaluation [DOT&E], 2005).

Based on the Army Ranger's 2005 assessment at Fort Polk, LA, that the LW was a suitable materiel solution, the VCSA directed the Army to conduct an LW DOTMLPF assessment to be held in 3QFY2006 by one Stryker battalion. The decision to field a Stryker battalion was based on its TO&E communications platform, the Stryker vehicle. Each vehicle came equipped with an EPLRS radio, and its interoperability with the LW and the lower tactical internet (LTI) provided the system interface the PM was looking for (Clifton & Copeland, 2008). After the poor battle command system assessment, the PM changed his acquisition strategy to integrate existing mature technologies from the battle command system program into the LW program. This differed from the PM's previous strategy because he no longer had to wait on the maturation of JTRS technology. This technology integration would further support the Stryker battalion fielding, DOTMLPF TTP assessment, and LUT planned for FY2006 (DA, 2005a). On June 28, GDC4S was awarded a sole source firm-fixed contract of $30 million to develop 372 LW systems and Stryker vehicle integration kits for evaluation into a Stryker battalion to facilitate the DOTMLPF TTP assessment (General Dynamics [GD], 2011).

During FY2005, the appropriations were divided between the battle command system and LW programs. According to the budget justification for February 2005 (R2a Exhibit), $72.9 million was spent on the LW program in support of developmental and operational tests and system engineering support for the overall program (DA, 2005a).

2. FY2006

a. Acquisition Strategy for FY2006

In 3QFY2006, the first spiral of the PM LW new procurement strategy equipped 4–9 IN with 372 LW prototypes to be tested during the DOTMLPF TTP assessment. Further, the outcome of the assessment would be used to define future spiral requirements for the program (DA, 2006).

In 4QFY2006, the 4–9 IN DOTMLFP TTP assessment successfully demonstrated the LW as an effective materiel solution. This provided Army leadership with the confidence the LW system would achieve an Milestone C (low rate initial production [LRIP]) decision by the Army Acquisition Executive (AAE) in FY2007 (DOT&E, 2006).

According to the 2006 Army research, development, test, and evaluation (RDT&E) budget, $49.5 million in funds were appropriated for the year; $24.9 million was requested for development engineering and $13.6 million to support program management and systems engineering (DA, 2006). Additional funds obligated for the program were other procurement Army (OPA) dollars in support of initial spares for $35.2 million. All told, the FY2006 budget for the LW program was $84.7 million.

3. FY2007

a. Acquisition Strategy for FY2007

In FY2007 the government exercised an option to the FY2005 sole source firm-fixed contract for $13.6 million to GDC4S for an additional 173 LW prototypes to support and train participants in preparation for the 4–9 IN DOTMLPF TTP assessment in support of a Milestone C decision (DA, 2006). This fielding supported the PM's program strategy to conduct the DOTMLPF TTP assessment with a Stryker battalion in support of a Milestone C decision. The 4–9 IN was given until the end of FY2007 (one year) to conduct training with the equipment before the evaluation. The basis of the issue fielding strategy was to issue the LW down to the TL (DA, 2007b). During the DOTMLPF TTP assessment in 2006, the PM LW saw the advantage of having the EPLRS-equipped Stryker vehicle in support of the LW. The EPLRS integration allowed the Stryker unit to talk to the LTI. As a result of their year-long training, the 4–9 IN

commander made the decision to take the LW system with them when they deployed to Iraq. The unit submitted an ONS for 450 LW systems, which was validated on January 11, 2007 (Geddes, 2011). A month later, due to significant Army-wide resource challenges, the Army decided not to pursue further development and production of LW prototypes (GAO, 2007). Despite the decision to cease development of the LW, the 4–9 IN deployed with the LW–Manchu system as a result of an ONS in March 2007.

Typically, an ONS supports a unit's nonstandard mission in which it is not equipped by Table of Organization and Equipment (TO&E) to accomplish (Headquarters, United States Army [HQDA], 2011). It was to address situational awareness gaps and squad-level (C2) gaps that the 4–9 IN commander submitted an ONS, as stated previously, resulting in the issue of the LW equipment down to the squad level (HQDA, 2011).

The ONS submittal process begins at the O-6 level and goes to the Office of the Headquarters, United States Army (HQDA), G-3/5/7, which is the overall approval authority for the process. The G-3/5/7 tries to respond to the ONS within 14 days of receipt but can take as long as 30–120 days. Once validated, the ONS may result in a DOTMLPF analysis—a directed requirement resulting in resources directly transferred to the unit, or a transfer of pre-positioned equipment, or it may result in no action at all. In situations of an urgent need, the Deputy Chief of Staff (DCS), G-3/5/7, has the authority to conduct a hasty assessment within 30 days to meet the warfighters' needs (HQDA, 2011).

Officially, in FY2007, the LW program of record was terminated by Claude M. Bolton, AAE, on February 20, 2007 (DA, 2007a). Prior to program termination, GDC4S completed its contract by delivering 450 LW prototypes. The terminated LW capabilities were transitioned to the third increment of the FFW NW Inc I.[21]

In response to the Army's decision to terminate the LW program, the Senate Armed Services Committee (SASC) authorized an $80 million plus-up in support of the 4–9 IN deployment. They appeared not to be satisfied with the Army's decision to cancel

[21] We discuss this increment in more detail in Chapter IV.

the program, and these funds ensured sufficient LW quantities to field to the deployed 4–9 IN battalion in Iraq (United States Senate, 2007). In addition, the committee made the following recommendation to the Army:

> The committee urges the Army to review its decision to terminate the Land Warrior program. Accordingly, the committee recommends an addition of $30.4 million in PE 64827A, and $49.5 million in Other Procurement, Army (OPA), to continue development of the Land Warrior program, and to procure LRIP items of equipment to field to the remaining two battalions of the Stryker brigade combat team currently equipped with Land Warrior. (United States Senate, 2007, p. 63)

Once the program was terminated and the 4–9 IN took the LW to combat, it essentially became an advanced concept technology demonstration (ACTD). The ACTD allows users to test and assess cutting-edge command, control, communications, computers, and intelligence (C4I) capabilities. ACTD is a process that allows programs to conduct early and inexpensive evaluation of mature advanced technology. This allows the program to vet the technology against the needs of the warfighter. The evaluation is accomplished by the warfighter—in the LW's case, through the ITA—to determine military utility before a decision is made to enter into the formal acquisition process. Additionally, ACTDs allow for user innovation, to develop and refine operational concepts that allow them to take full advantage of the capability (DAU, 2011b).

4. FY2008

a. Acquisition Strategy for FY2008

The Senate Armed Services Committee's previous year's authorization of $80 million was appropriated and increased to $93.9 million in order to support the LW during its deployment to Iraq (DA, 2009a).[22] As discussed in the termination plan for the LW, the project manager, COL Hansen (2007), PEO–S, offered extenuating and mitigating circumstances to be considered by the AAE while evaluating the program termination. According to Hansen (2007) in the *Land Warrior Termination Plan*,

> Land Warrior Equipping Production (W15P7T-05-C-F201) ($29.7M for the Firm Fixed Price contract for LW hardware for the VCSA-directed

[22] This information was retrieved from the May 20, 2008, Congressional record addressing the 2008 War Supplemental (HR 2642), provided by John Geddes, Assistant PM LW/NW.

> DOTMLPF Assessment and negotiating a Time and Materiels contract for OIF Contractor Logistics Support (CLS), total est. is $39M). This production contract with GDC4S was awarded to produce the systems required for the VCSA-directed DOTMLPF Assessment and LUT conducted during 2006. Current activities under this contract include buying additional LW components as spares to support 4–9 INF [*sic*] BN (4/2 SBCT) deployment and providing for CLS for both training exercises and OIF deployment. We recommend that this contract remain active until the end of FY08 to support the 4–9 INF [*sic*] BN (4/2 SBCT) deployment. (p. 4)

Essentially, he was asking the AAE to consider the support plan for the soldiers of 4–9 IN and the need for additional systems to support their efforts. The PM LW also had personnel (FSRs) providing theater support to the deployed system and asked that they be retained as well. He received additional systems for spares and retained his FSRs for the remainder of the 4–9 IN deployment. All told, GDC4S delivered 400 LW systems to complete its contract in support of the deployed 4–9 IN (Geddes, 2011).

The LW program also received funds from other contingency operation (OCO)[23] OPA dollars (Geddes, 2011). The funds sought out for the FY2008 budget would support the 5/2 SBCT ONS validated in December 2007 (Office of the Deputy Chief of Staff, G-3/5/7 [DCS, G-3/5/7], 2007).

5. FY2009

a. Acquisition Strategy for FY2009

In FY2009, PM LW refocused the program strategy to begin disposal of the LW–Manchu and field the LW–Strike.[24] In order to support this strategy, the Army requested, in their main supplemental funding, $700,000 to begin the LW–Manchu disposal process. An additional $48.3 million funded the program through two separate sources: PEO–S conducted below-threshold reprogramming in their OPA budget for $19.9 million, and the HQDA conducted an above-threshold reprogramming for $30 million (Geddes, 2011). These funds supported the 2SCR ONS through contracted FSRs who supported the program as subject matter experts (DCS, G-3/5/7, 2009). In addition to the

[23] Global War on Terror Supplemental funds are known as other contingency operation or OCO funds.

[24] LW–Strike is discussed in detail in Chapter III.

reprogramming listed above, the program received an additional $62 million in OPA funds. This would support the fielding of the enhanced LW–Strike system to 5/2 SBCT. Fielding of the LW–Strike began in April FY2009 and ended in July FY2009. A total of 895 systems were delivered to the Army by GDC4S.

Additionally this year, the PM became duel hatted when the NW Inc I began its life cycle. In February, the NW Inc I was approved for entry into technology development. The program is estimated to cost $1.6 billion over its life cycle for a total of 20,430 NW Inc I systems planned for procurement by the Army. The total program funds breakdown for RDT&E is estimated at $179.8 million and $1.48 billion for procurement. The NW Inc I system, including all government-furnished property (GFP) and CFP listed in Chapter IV, is scheduled to reach low-rate initial production decision authority by FY2011 (GAO, 2011).

In April, the U.S. Army Contracting Command awarded contracts to three vendors to develop the NW system for testing and evaluation. The three contractors were each awarded a CPFF with values between $16.4 and $17 million respectively (United States Army Contracting Command [USACC], 2011).

6. FY2010

a. Acquisition Strategy for FY2010

Appropriations for FY2010 totaled $40.2 million, which funded redeployment and training for units using the LW–Strike system: $9.6 million funded the logistical support during the last quarter of 5/2 SBCT deployment; $21.4 million funded the 2SCR NET and deployment to Afghanistan; and $9.2 million funded NET for 1/25 SBCT (Geddes, 2011).

Beginning January 2010, the NW program began developmental testing on the NW Inc I system. In March, the 5/2 SBCT redeployed from Afghanistan and transferred 895 LW–Strike systems to theater provided equipment (TPE). The 2SCR was still preparing for its deployment and was not physically in theater to receive the system directly from 5/2 SBCT. The 2SCR signed for the LW–Strike TPE in May and used the

system until April 2011. In August the 1/25 SBCT received validation for an ONS to use the LW–Strike and support systems being used by 2SCR (DCS, G-3/5/7, 2010).

Long lead items[25] for the NW, under the name Ground Soldier System (GSS),[26] were procured at $18 million, consisting of RT-1922 radio (RR), GB GRAM Selective Availability Anti-Spoofing Module (SAASM) GPS receiver, battery power, and SBCT VIKs (DA, 2009a).

7. FY2011

a. Acquisition Strategy for FY2011

As of this writing, the FY2011 funds for the NW were not available and are not included in this paper.

D. SUMMARY OF KEY LAND WARRIOR/NETT WARRIOR DECISIONS

In this chapter we discussed the support Congress showed the LW program after it was terminated. Congress continues to support the program today. We discussed the decision of the Army to terminate the LW program and the implications on the program as a result. Some decisions temporarily set the program back, for example, the DBCS program integration in FY2005 that resulted in the splitting of the PM LW program funds. Conversely, the failure of the battle command system, which proved unreliable and not ready for fielding, helped the PM LW solve technology challenges with the integration of the EPLRS radio. Another example is the decision to field the LW with the Manchus of 4–9 IN, whose deployment inspired the SBCT community to believe in the capabilities of the LW. The ensuing interoperability with the EPLRS network through a Stryker-mounted VIK could link into the LTI. This led to fielding of one battalion within the SBCT community, the 4–9 IN Manchu. The 4–9 IN would become the first unit to successfully demonstrate communications from the ground soldiers to their leadership

[25] Advanced procurement funds are used in major acquisition programs for advance procurement of components whose long lead-times require purchase early in order to reduce the overall procurement lead-time of the major end item.

[26] The budget item justification refers to the Ground Soldier System (GSS). For continuity and clarity, we will continue to call the GSS the NW.

through the LTI. The LW was no longer seen as a light infantry capability; instead it became a staple within the SBCT community.

In this chapter we discussed the importance of the ONS process and how it ultimately became the lifeblood of the LW program following the Army's decision to cease production of any additional prototypes in FY2007. Finally, we discussed the FY funds breakout from FY2005 to FY2011, as illustrated in Figure 27.

	2005	2006	2007	2008	2009	2010	2011
Unit Activity		First spiral LW equips 4-9 IN 4-9 IN demo materiel solution as viable	4-9 IN ONS validated, deploys to OIF 4-9 IN continues to refine the LW system; GDC4S makes changes to system in theater	5/2 SBCT ONS was validated	5/2 SBCT NET 5/2 SBCT deploys to OEF (895) TPE 2 SCR ONS was validated	1/25 SBCT ONS validated 2 SCR deploys to OEF (LW TPE)	1/25 SBCT deploys to OEF (LW TPE)
Fund Activity	$72.9M- R&D ($30.8 M OPA dollars)	RDT&E- $49.5M $24.9M DE $10.9M Training $13.6M Support Initial spares $35.2M (OPA) Total $134.1 million	LW was programed for a total of $207.5 million for a total of 1,954 systems through FY11 -- SASC earmarked $80M to support ONS	Earmarked $80M increased to $93.9M -- Funded by OCO OPA dollars	$49.9M obligated; OPA budget $19.9M and HQDA $30.06M (reprogrammed dollars) -- $700,000 OCO: LW-Manchu disposal -- $1.6 B NW Inc I Funds obligated R&D equaled $179.8M $1.48B procurement	No base funds programmed for LW Total NW Funds $40.2M; $9.6 million funds 5/2 SBCT deployment; $21.4M funds 2SCR NET and deployment; $9.2M NET for 1/25 SBCT	$21.8 million (OCO) in support of ONS for LW $110.5M- NW- Base procurement

Figure 27. FY Budget Breakout from FY2005 to FY2011

In FY2006, the 4–9 IN participated in the LW capstone event, a LUT. Its success in that evaluation encouraged the Army and Congress that the program, despite the delays and schedule shifts over the last decade, was still progressing toward a Milestone C decision. Congress' willingness to support LW (at least as an interim solution) was necessary to extend funding of the program after it was terminated in FY2007.

In FY2007, the 4–9 IN received deployment orders to OIF in support of the "surge" in Iraq. As the testing unit, this news disrupted the planned equipment evaluation scheduled in support of an Milestone C decision. The Army made the decision to terminate the LW program based on budget constraints and the loss of the testing unit, the 4–9 IN, when it deployed to Iraq. Thus began a period during which the LW was funded only in support of the ONS. Research suggests that 4–9 IN's deployment solidified the LW as a limited materiel solution that supported the SBCT community for the next five years, while providing significant system lessons learned that would help shape the maturation of the technology, benefitting both LW and the emerging NW.

In FY2008, Congress authorized $80 million to support 4–9 IN deployment and NET for the 5/2 SBCT conducted in preparation for their deployment to Afghanistan.

FY2009 was the first year funds were authorized for the NW Inc I in support of its entry into technology development. Additionally, long lead items were procured for the NW Inc I in anticipation of the FY2011 LUT and down-select. In 4QFY2009, the ONS for 2SCR was validated, resulting in the LW program’s third deployment and second rotation to Afghanistan. In 3QFY2011, three vendors were selected to develop NW Inc I prototypes for a competitive down-select resulting in a firm-fixed-price contract. As of this writing, a vendor has not been selected. To date, Congress continues to fund the NW program and the PM continues to evolve the program strategy based on guidance and policy received from the HQDA and user community. When asking where the funds came from that supported the LW program long after it was cancelled, we suggest in this report that the funds spanned the spectrum of Army budgets. We believe the 4–9 IN was pivotal to the extended use of LW, albeit on “life support”; without the 4–9 IN ONS, the program would have died in FY2007. Several LW deployments to Iraq and Afghanistan smoothed the way for the eventual emergence of the NW program.

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IV. CASE STUDY SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

A. SUMMARY

The NW is the result of the long and turbulent program history of the LW. Since the Cold War, the Army's priorities have continued to evolve, emphasizing a shift towards net-centric warfare as we fight the Global War on Terrorism (GWOT) and strive for overmatch of future combatants. The context in which the requirements for a dismounted battle command system were derived and evolved has played an instrumental role in the future of NW. The materiel developer has contributed to the programs many successes while encountering stubborn obstacles. The PM's efforts can be illustrated as attempting to incorporate the edge of technology to meet the program's functional requirements. The greatest challenge the PM has to overcome is immature technology, funding instability, and conflicting priorities and perspectives from the user community. The PM has yet to find a one-size-fits-all solution, evident by the modifications to the LW system, the user's feedback from Afghanistan, the ATEC LUT results, and further compounded by differing levels of user buy-in.

Finally, from a fiscal perspective, a nation that is asked to "do more without more" further exacerbates the pressure for the PM to find a more cost-effective materiel solution. These constraints lead to mixed results that can be either a hindrance or a benefit to the program. Examples of this include the outcome of the 2010 LUT, resulting in the fear of cancellation, which caused a new direction for the program. This was mainly based on the dependency of an unproven radio system and the integration/application challenges of integrating smart phone (EUD) technology. All this culminated in the CSB directing the PM to incorporate smart phone technology.

B. CONCLUSION

We organized this case study's conclusion in an effort to merge the previous chapters' fundamental topics related to the NW current status. By highlighting the key lessons learned, we can better understand the driving forces behind the NW acquisition

(historical context, user representatives, materiel developers, warfighters, and funding), draw conclusions, and generate recommendations for potential ways ahead for similar acquisition programs. In addition, we can incorporate some of the lessons learned from the CSB's involvement with the NW program into the strategic perspective of DoD acquisition. Lastly, we provide recommendations for further research as the topic of a digitized, networked soldier will continue to be a topic of importance and concern.

From our perspective there were four key turning points in the development of the NW program, as follows:

1. A battalion commander's decision to take LW into Iraq contributed to the 4–9 IN's success in a combat environment. The 4–9 IN's efforts not only saved the LW program, but also breathed new life into the effort to digitize the soldier. This eventually led to the development of the NW.

Through the ONS process, a deploying commander requested the LW system for his battalion. This laid the groundwork for follow-on SBCT's—based on 4–9 IN success—to realize the capability of LW and similarly submit an ONS requesting the system. While fulfilling operational needs, the PM LW was able to harness soldier feedback to improve the LW system. In effect, the Army's scrapped program received a reprieve, for limited use, because it was the best choice to fill capability gaps in combat. System use in Iraq permitted onsite support personnel (USIs, FSRs, and TCM–S) to gather soldier feedback that could be used to improve the system. This operational experience allowed technology maturation of the NW equivalent to the technology development phase of a traditional acquisition life cycle.

An ongoing challenge inherent to any new system is user buy-in, which is critical to system success. User buy-in is encouraged by resourcing a unit with adequate systems in order to train and become familiar with the new equipment. The Manchus trained on the system for over a year prior to deploying and favored the system. Due to a limited availability of training systems, units after 4–9 IN were not afforded the same opportunities to become familiar with the system. These units received the LW–Strike system as TPE and had, at best, four months of training. Research into their training schedules shows the blocks of training were one to two days, divided by weeks of other

deployment training tasks. Essentially, this training was nothing as substantial as the training 4–9 IN received.

During the course of the LW's time in combat, user buy-in demonstrated a diminishing scale of acceptance based on the emergence of smart phone technology. Reviewing the overall success of the program, comparing the 4–9 IN ITA and the last three units' feedback, the highest program growth was achieved during 4–9 IN, and then the user acceptance began to drop. Beginning with 5/2 SBCT, research shows soldiers wanted the technology of the LW but packaged similar to that of a smart phone in size and weight. A discussion with NW APM John Geddes (2011) revealed that the unit that will conduct an RIP with 1/25 SBCT did not submit an ONS for the LW. Instead, the unit chose to wait for the Army to field the smart phone technology. Mission tempo and type are additional reasons for the decline of solider buy-in during operations in Afghanistan. The utility of the NW system is dependent on the ability of a unit to generate a robust network in the terrain they are fighting in. The largely mountainous and isolated terrain does not lend itself fully to the capabilities provided by the EPLRS network. We note this specifically in our discussion on the 2SCR post-combat surveys in Chapter III.

2. The continuous ONS submissions reinforced the user need for the LW soldier system long after the Army terminated the program. The user's feedback over four combat deployments was the foundation for the NW program. Through the user in-theater tests, the NW benefited significantly from technology improvements from the LW program.

The ONS process is unique to the LW program in that it allowed the system to continue serving the warfighter after the program was terminated. Looked at holistically, the LW systems' purpose was specific to enhanced SA for the light infantry combat teams. In today's GWOT mission, we are no longer fighting predominately with the light infantry. Combine that with the CSB de-scoping efforts resulting in a lighter and more cost-effective program, the Army is now postured with a solution that fits the needs across the force structure.

The lesson is that the ONS provided a non-standard way to mature the technology. Through the LW program, the Army provided soldiers SA that was better

than they had, while affording PM LW/NW an opportunity to gather feedback from an ACTD.

3. The ATEC results proved to be more than the program could overcome. Hoping to achieve a Milestone C decision based on its performance in the October 2010 LUT, the NW program once again failed to prove its overall effectiveness. In the Army's eyes, the program had failed to receive approval to "prime time." The lesson learned is that technology was not sufficiently mature to support NW.

4. The 2011 CSB modification to the NW requirements proved to be the most recent and perhaps the most important event to date. This allowed the de-scoping of the materiel developer's efforts. The PM refocused the program strategy on the most beneficial and openly praised capabilities of all previous versions of the NW (enhanced SA, accurate position location, and precise navigation). PM NW was released from an array of system requirements that exceeded current technological capabilities. The CSB's actions may prove to be a crucial turning point for the future of the networked soldier.

Through the CSB, the PM NW was authorized to incorporate emerging commercial technology. As we mentioned in Chapter IV, this allowed the PM to pursue a materiel solution that was 70% lighter and saved the Army more than 50% in overall cost. Although these decisions resulted in a lighter and more cost-efficient program, it also left significant risk to NW. The system PM was no longer responsible for the radio system that would mesh the NW with the network. This made the system dependent on the maturation of the RR program. We note that the difference between the LW and NW communications system is that the LW was on a parallel path with the RR and planned to incorporate it when it became available. The NW is on a converging path with the RR, which means the NW program's success is directly tied to the success of the RR.

C. ANALYSIS OF THE ACQUISITION STRATEGY ELEMENTS

In this section, we examine how the NW program addressed key elements of an acquisition strategy. The four key elements of NW's acquisition strategy this report focuses on are mission need, test and evaluation, technology, and risk management.

1. MISSION NEED

Evidenced by the four operational need statements submitted between 2007 and 2010, soldiers in Iraq and Afghanistan required a system that provided SA over-match in the dismounted fight. The urgency for delivering a dismounted soldier system meant that soldiers were willing to take a system like the LW, which had been terminated in February 2007; although the LW had flaws that prevented it from becoming the Army's standard dismounted soldier system, it did exhibit useful attributes that filled operational gaps, which made it the best system available for limited use when urgent needs required it.

The CSB's actions reinforced the urgency with which the Army intended to deliver a networked dismounted soldier system. The PM and user representatives were empowered to shift focus towards delivering a less expensive, limited-scope device that was readily available. The success of 4–9 IN's operations in Iraq demonstrated the benefits of the soldier system. The LW enabled the dismounted soldier to operate in unfamiliar and dense or urban terrain with similar SA to that of the mounted elements using Blue Force Tracker (BFT) systems.

2. TEST AND EVALUATION

Since LW–Strike was not a program of record, the PM was unable to make significant improvements to the LW system. By incorporating the radio, battery, and software from the LW–Strike system, the NW also inherited the shortcomings of those components, which included communication, reliability, and weight issues. During the NW LUT in 2010, these shortcomings were reported by ATEC's assessment. The results of the NW LUT should have been no surprise, due to the operational feedback received from Afghanistan. The comments from 2SCR's post-combat survey identified several system challenges; one of the most significant was the limited communication range while operating in steep, rugged terrain. In such terrain, dismounted elements were not supported by a vehicle-mounted EPLRS network, which resulted in significantly decreased network range. In addition, it was noted that the weight, bulk, and sustainability of the system during dismounted operations was a significant burden.

In our view, the four combat deployments with LW-equipped units provided an extensive ACTD for NW. In this aspect, the NW program had a distinct advantage over other programs. Typical testing environments do not fully achieve the stress and variability of actual combat. This paper suggests the four operational deployments enabled the PM and TCM–S to gather relevant and realistic feedback concerning a dismounted soldier system and permitted opportunity for experimentation. However, it must be mentioned that, unlike more tightly controlled test environments, actual combat conditions presented challenges in gathering complete data from both soldier feedback and system failures.

3. TECHNOLOGY

By incorporating seemingly mature technology from the LW system, the NW intended to achieve a higher technology development rating, leading to the abbreviated acquisition strategy. But without significant improvements to the radio, software, and battery, the NW system was unlikely to make substantial improvements to performance and sustainability. As demonstrated in Afghanistan, soldiers will continue to fight in various types of terrain, which will not only place strain on the soldier, but may also exceed the limits of our technological capabilities. Connectivity within the EPLRS network and limited range remain a challenge to the LW system.

The CSB's decision to de-scope the requirements put NW on a new technological path. The CSB signaled a transition in the acquisition community to deliver products in a timely manner comprised of more relevant technology. The introduction of the smart phone device provided the mature technology required to maintain the current level of capabilities while substantially reducing weight. The NW program was finally authorized, and seems positioned, to deliver a materiel solution that soldiers have been asking for, a LW-Lite. Since 1993 the Army has been trying to provide a capability to soldiers that was simply not technologically mature. Although it appears that the technology may now be mature enough to support the NW requirements, the final answer to this must await completion of rigorous developmental and operational testing of the new version that integrates RR and EUD into NW.

4. RISK MANAGEMENT

Use of the LW technology was intended to reduce technology risk, accelerate the development of the NW, and decrease the program's life cycle cost. Unfortunately, little weight was shed because the vendors were provided the battery, CPU, and radio from the previous system—collectively the bulk of the weight the system needed to shed. This strategy put the NW program at risk as operational feedback continued to indicate that the LW system weighed too much.

At the Army level, the CSB's involvement with the NW program served as a risk mitigation mechanism. The CSB considered ATEC's recommendations that the NW system not deploy until the system demonstrated an improved technical performance. The CSB's directive to incorporate a smart phone technology device enabled the PM to make major changes to the program's direction while minimizing the impacts to overall program cost and schedule.

D. RECOMMENDATIONS

LW and NW are examples of programs that tried to use technology that was immature and unready to support the system. This was a major failing in the emerging LW and NW programs. Programs must demonstrate that they are technologically ready to move beyond Milestone B. This is evident by the poor showing in the 2010 NW LUT results and involvement by the CSB.

Dismounted soldiers continue to have capability gaps that need immediate solutions for soldiers in combat. The ONS provided a useful mechanism that assisted deployed and deploying forces with limited materiel solutions in the form of developmental systems not yet ready for standard issue. The answer to filling a gap may be an ACTD, which is, in fact, what LW really became after it was terminated.

The CSB showed its worth in the case of NW, by permitting relief from requirements and the direction to adopt smart phone technology. Trigger CSBs should be required for any system that stumbles at a milestone decision point.

The NW program is not out of the woods yet. Although the EUD and RR offer an innovative integrated solution, the success of this approach must be proven in rigorous developmental and operational test and evaluation. Programs should never be pushed along to the next acquisition phase without demonstrating readiness to meet typical exit requirements. That includes NW, even after the CSB rescued it from the brink. It must demonstrate that it can meet KPPs and that it is reliable, affordable, suitable, effective, and survivable.

From a strategic perspective, there are several key takeaways to consider:

- Although not ideal, soldier feedback from operational deployments warrant additional scrutiny. Due to the mortality of a combat situation, soldiers make candid comments that should be exploited when refining the user requirements.
- Adapting commercial technology to meet military requirements does not always lead to reductions in program cost and schedule.
- TRADOC is responsible for generating the requirements for the Army. However, TRADOC may not be able to accurately derive Army needs. TRADOC must become more attune to the ever changing needs of the soldier. Without properly defining the requirement, a program manager cannot be expected to deliver a one size fits all type of solution.

E. PATH FORWARD

The value of a battle command system has been proven several times over to the Army, which explains the two decades of development that has led up to this point. Soldier systems and technology are on a critical path. These systems will become common across the Army. Likewise, many other countries have developed soldier systems similar in capability to the NW.

The long-term goals for the NW program call for integration into a unified battle command system. One of the most significant objectives involves creating an almost omnipotent awareness and understanding of friendly and enemy forces across a fully networked battlefield. The resulting synergy will foster a common operating picture that fully integrates Army ground, mounted, and rotary and fixed-wing aviation. The network of the future will facilitate decentralized operations across a non-contiguous battlefield with no disruption to communications across the Service branches.

F. RECOMMENDATIONS FOR FURTHER RESEARCH

As the future of the NW program remains unclear, numerous questions remain unanswered and provide an opportunity to make recommendations for further research and study.

First, an on-going challenge is associated with providing a dismounted, networked soldier system capability to the IBCT. This issue continues to be one of the biggest hurdles for future soldier systems. Lacking platforms to host network enablers, the IBCT lacks robust communications architecture.

Second, the notion of leveraging soldier-driven, human factored engineering was a strength of the 4–9 IN experience. The Army has created an evaluation unit, the 5th BCT, 1st Armored Division, AETF at Fort Bliss, TX, and the 1st Battalion, 29th Infantry Regiment EXFOR, for this very purpose. It would be beneficial to the Army acquisition community to study how these organizations can be leveraged to maximize risk reduction, improve human factors engineering, and harvest user feedback from an operational environment.

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